Shell Exploration & Production Company
3601 C Street, Suite 1334
Anchorage, AK 99503

January 24, 2007

National Marine Fisheries Service
Office of Protected Resources
Marine Mammal Division
Attn: James H. Lecky, Director
1315 East - West Highway
Silver Spring, MD 20910-3226

Subject: Request for Approval, Incidental Harassment Authorization for Non-Lethal Taking of Whales and Seals in the Beaufort Sea, Alaska During 2007 Open Water Drilling Program

Dear Mr. Lecky:

Shell Offshore, Inc. (SOI) proposes to drill priority exploration targets and geotechnical boreholes during open water season on various U.S. Minerals Management Service (MMS) Outer Continental Shelf (OCS) lease blocks in the Beaufort Sea. SOI requests an Incidental Harassment Authorization (IHA) pursuant to Section 101 (a) (5) (D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371 (a) (5), to allow non-lethal takes of whales and seals incidental to offshore drilling operations.

The only type of incidental taking sought in this application is takes by noise harassment stemming from the vessels and support vehicles associated with SOI's exploration and geotechnical drilling activities during the 2007 open water season. The semi-submersible drilling unit Kulluk (Kulluk) and the Frontier Discoverer Drilling Vessel (Discoverer) will be utilized in the open water exploration drilling operations. Each will be accompanied by up to two arctic-class, foreign-flagged, ice management vessels, which will provide support tasks. Additional support vessels and aerial support craft will also assist with crew change support and provision re-supply. Drilling activities will operate with marine mammal monitoring and mitigation measures negotiated within the Conflict Avoidance Agreement (CAA) between Shell and the Alaska Eskimo Whaling Commission (AEWC) and whaling captains from the AEWC villages of Barrow, Kaktovik, and Nuiqsut. Aerial support craft will be operating within flight controls mandated by the CAA and/or other stipulations compliant with MMS National Environmental Policy Act (NEPA) documents. Oil spill response vessels will accompany the drill ships at a minimum while drilling occurs through prospective hydrocarbon-bearing zones. Pre-feasibility geotechnical borehole drilling will be conducted by a vessel typically over 200 feet in length, with a moonpool and drilling rig approximately at mid-ships, A-frame stern, helideck above the bow/bridge and accommodations for about 40 technical staff and crew.

The proposed Beaufort Sea exploration and geotechnical drilling activities will commence during the open water season. Accompanied with two foreign-flagged ice management vessels, the Kulluk will transit from McKinley Bay to the Alaskan Beaufort Sea around mid-July and be ready to initiate drilling by August 1, 2007. In early, to mid-July 2007 the Discoverer will be escorted by two additional ice management vessels from the Bering Sea port of Kotzebue towards drilling prospects in the Beaufort Sea where ice conditions provide safe operating access. Demobilization for both the Kulluk and Discoverer is anticipated before November 1, 2007. The pre-feasibility geotechnical borehole drilling is expected to begin during July 2007. Including weather, ice conditions and logistics/resupply it is anticipated that geotechnical borings may require up to eight weeks within a 12 week timeframe finished by early to mid October 2007. The geotechnical drilling activity is included in the CAA currently in negotiation with AEWC and AEWC villages.

The open water activities proposed by SOI for 2007 will continue to be discussed with the affected communities. SOI held Plan of Cooperation (POC) meetings in the communities of Nuiqsut and Barrow on October 16-17, 2006. Public meetings will be held in Barrow, Kaktovik, and Nuiqsut during late January and early February 2007 to discuss industry-wide 2007 proposed activities with these communities. Additional follow-up POC meetings specific to SOI's activities will occur during May or June 2007 in the affected communities. Negotiations were initiated with AEWC beginning September 2006, and continued in October during the Alaska Federation of Natives (AFN) conference in Anchorage to create a CAA between SOI, and the Whaling Captains' Associations of Kaktovik, Nuiqsut, and Barrow for the 2007 activities. SOI has participated in early consultation and coordination with Native entities that conduct subsistence activities in the proposed drilling area and conveyed a strong desire for avoiding potential conflicts.

Any impacts on the whale and seal populations of the Beaufort Sea from the drilling activity are not expected to have any habitat-related effects that would produce long-term affects to marine mammals or their habitat, due to the limited extent of the activities and timing of the activities. The drilling activities will not result in any permanent impact on habitats used by marine mammals or their prey sources. There should be no adverse impacts on the availability of the whale species for subsistence users.

Items presented pursuant to 50 C.F.R. § 216.104, "Submission of Requests", and § 216.107, "Incidental Harassment Authorization for Arctic Waters", are attached with the application.

Please contact me at (907) 770-3700 for further information.

Sincerely,
Shell Exploration & Production Company

Susan Childs

Susan Childs
Regulatory Affairs Coordinator, Alaska

15214-D/O7-022

Attachment:

- Application for Incidental Harassment Authorization for the Non-Lethal Taking of Whales and Seals in Conjunction with a Proposed Open Water Drilling Program in the Beaufort Sea, Alaska, During 2007

cc w/attachment:

Maggie Ahmaogak, Alaska Eskimo Whaling Commission - Barrow, AK
Jessica LeFevre, Alaska Eskimo Whaling Commission – Washington, D.C.
Doug DeMaster, NOAA Fisheries - Seattle, WA
Ken Hollingshead, NOAA Fisheries - Silver Spring, MD
Brad Smith, NOAA Fisheries - Anchorage, AK
Arnold Brower, Jr. - ICAS
Mark Stone - SOI
Chandler Wilhelm – SOI
A. Michael Macrander – SOI
Greg Horner – AES-RTS
Jeff Walker – MMS
Project File
Administrative File

Application for Incidental Harassment Authorization for the Non-Lethal Taking of Whales and Seals in Conjunction with a Proposed Open Water Drilling Program in the Beaufort Sea, Alaska, During 2007

January 2007

Submitted to:

Shell Offshore Inc.
3601 C Street, Suite 1334
Anchorage, Alaska 99503

Prepared by:

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory & Technical Services
3900 C Street, Suite 601
Anchorage, Alaska 99503

Table of Contents

Page

Figures

Tables

Attachments

Shell Offshore Inc. (SOI), a legal entity of Shell Exploration & Production Co. used the following guidance to prepare its request for Incidental Harassment Authorization (IHA).

> 50 CFR 216.104 "Submission of Requests"
>
> (a) In order for the National Marine Fisheries Service (NMFS) to consider authorizing the taking by U.S. citizens of small numbers of marine mammals incidental to a specified activity (other than commercial fishing), or to make a finding that incidental take is unlikely to occur, a written request must be submitted to the Assistant Administrator. All requests must include the following information for their activity:

1. A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals:

Information required by 50 CFR§216.104 (a):

Open Water Exploration Drilling

SOI is planning to utilize two drilling units during the 2007 open water season in order to drill priority exploration targets on their U.S. Minerals Management Services (MMS) Outer Continental Shelf (OCS) leases in the Beaufort Sea. The highest priority exploratory targets for 2007 are located offshore of Pt. Thomson and Flaxman Island in Camden Bay. However, given the locations of open water conditions during 2007 and permit/authorization stipulations, SOI may elect to re-prioritize well locations on one, or more of their OCS leases (see Figure 1).

In March 2005, SOI acquired 84 leases during MMS OCS Lease Sale (LS) 195. SOI's leases acquired from MMS contain seven stipulations drawn from the environmental impact statement completed for LS 195, including two directly relevant to SOI's IHA application. These are a site-specific bowhead whale monitoring program and conflict avoidance mechanisms to protect subsistence whaling and other subsistence-harvesting activities. SOI's marine mammal monitoring and mitigation plan included with this application is compliant with these MMS stipulations.

The drilling units proposed for the 2007 OCS drilling program include the semi-submersible drill ship, the Kulluk, and a floating drill ship the Frontier Discoverer (Discoverer). Both the Kulluk and Discoverer will be mobilized into the Beaufort as soon as ice conditions permit. Each will be accompanied by up to two arctic-class, foreign-flagged, ice management vessels which will also serve duty as anchor tenders, and other drill ship support tasks. These ice management vessels are: M/V Jim Kilabuk of the Northern Transportation Company, M/Vs "Vladimir Ignatjuk" and "Kapitan Dranitsyn" of the Murmansk Shipping Company fleet; M/V Fennica-Nordica of Finstaship (Finnish Shipping Enterprise); and the M/V Tor Viking of Viking Supply Ships.

Additional support vessels, such as the M/V Peregrine and aircraft (marine mammal monitoring aerial overflights) will also be used during the drilling season, helping with crew change support and provision re-supply. Oil spill response vessels (OSRV) will accompany the drill ships, at a minimum while drilling occurs through prospective hydrocarbon-bearing zones. Projected dates for arrivals of OSRVs on location in the Beaufort Sea will be more firmly known toward the end of April/May 2007. An ice-class, purpose built OSRV is being constructed for SOI and will be deployed in the Beaufort Sea for this drilling program. Potential OSRV support includes the Arctic Endeavor barge and associated tug; and an OSR tanker that will be staged in proximity to both drilling units. A list of specifications for the Kulluk, Discoverer and prospective ice management vessels is included as Attachment A.

The Kulluk is 81 meters (m) (266 feet [ft]) in diameter with an 11.5 m (38 ft) draft when drilling. It is fixed in place using 12 anchor wires (3.5 inches [in] diameter), each connected to a 15 ton anchor. The Kulluk is currently moored in McKinley Bay, Yukon Territory, Canada. Ice management support (M/V Vladimir Ignatjuk and M/V Fennica-Nordica) for the Kulluk are projected to enter the Beaufort Sea during mid-late June 2007 traveling west to east toward McKinley Bay. The Kulluk is projected to be towed into the Alaskan Beaufort Sea during July 2007 by one of the arctic class ice management vessels, which travel through the Chukchi and Beaufort Seas before arriving in McKinley Bay for mobilization.

The Discoverer is 156.7 m (514 ft) in length with a maximum draft of 8.2 m (27 ft) and is anchored using eight points. The Discoverer is currently docked in Singapore and will travel to Kotzebue for re-supply before mobilizing into the Beaufort Sea, accompanied by ice management vessels. The M/V Kapitan Dranitsyn will provide ice management support for the Discoverer. Both ships are expected to depart Kotzebue in early July before entering the Beaufort Sea.

The Kulluk and Discoverer, and all support vessels and aircraft will operate in accordance with the conditions of a Conflict Avoidance Agreement (CAA) currently being negotiated with the Alaska Eskimo Whaling Commission (AEWC). The drilling CAA will provide guidance toward mitigating any potential adverse effects on the bowhead whale subsistence hunts by member of the villages of Kaktovik and Nuiqsut.

Pre-Feasibility Geotechnical Borehole Drilling

As many as eight boreholes, each up to 400 ft in depth, will be drilled to obtain geotechnical data for pre-feasibility analyses of shallow sub-sea sediments. These boreholes will be completed at depths more than one mile above any of the prospective subsurface hydrocarbon-bearing zones in the Sivulliq prospect (see Figure 1). Three potential development locations will be investigated at Sivulliq, deeper locations along a prospective pipeline access corridor will also be investigated (Figure 1). This operation is expected to take approximately one week per borehole.

Shallow sub-sea bottom sampling for geotechnical analyses along the access corridor, and other features of interest identified by geophysical marine surveys (i.e., site clearance activities) covered by a separate IHA application may occur. Shallow sub-sea bottom sampling will use a seabed frame to either push a sample tube or a cone penetration test into the seafloor.

The geotechnical survey component of the program will be conducted by a vessel typically over 200 ft in length, with a moonpool and drilling rig approximately at mid-ships, A-frame at the stern, helideck above the bow/bridge and accommodations for about 40 technical staff and crew. A typical geotechnical coring vessel is illustrated in Attachment A. SOI will select the contractor to conduct this activity during January 2007. Afterwards, the name and specifications of the vessel should be known and SOI will then inform NMFS.

Geotechnical activities will occur in accordance with the provisions of the drilling CAA with the AEWC.

2. The dates and duration of such activity and the specific geographic region where it will occur:

Open Water Exploration Drilling

SOIs' highest priority drilling prospects for the 2007 open water season occur on the leaseholds referred to as Sivulliq and Olympia (Figure 1), located in Camden Bay of the Beaufort Sea. However, SOI reserves the option of re-prioritizing drilling locations due to ice conditions during the 2007 open water season. Re-prioritizing of drilling prospects due to ice may cause drilling to occur at other Beaufort Sea OCS leases held by SOI, but only those that have been pre-cleared to the satisfaction of MMS. It is anticipated that the Kulluk and Discoverer will each drill up to two wells during the open water season of 2007.

Two foreign-flagged ice management vessels (the M/V Vladmir Ignatjuk and M/V Fennica-Nordica) will be tasked with accompanying the Kulluk from McKinley Bay to the Alaskan Beaufort Sea. These vessels will traverse the Alaskan Beaufort from west to east and are projected to begin the traverse before July 1, 2007. These vessels should free the Kulluk and ready it for mobilization to the Alaskan Beaufort Sea by late July or early August 2007. The M/V Tor Viking is projected to enter the Beaufort Sea during mid-late June 2007 and arrive on location of the Sivulliq prospect in late June. The M/V Jim Kilabuk will provide support and supply to the Kulluk. Toward the end of July, an additional ice management vessel (the M/V Kapitan Dranitsyn) will escort the Discoverer from the Bering Sea northward through the Chukchi and Beaufort Seas to drilling prospects where ice conditions allow safe operating access. At the conclusion of open water operations around the end of October 2007, SOI expects to demobilize both the Kulluk and the Discoverer before the end of November 2007. The Kulluk will be accompanied by two ice management vessels back to the Canadian Beaufort Sea (McKinley Bay), while two ice management vessels will accompany the Discoverer west through the Beaufort Sea and south through the Chukchi Sea.

Pre-Feasibility Geotechnical Borehole Drilling

The geotechnical drilling is expected to begin during July 2007. Including weather, ice conditions and logistics/resupply it is anticipated that geotechnical borings may require up to eight weeks within a 12 week timeframe finished by the end of October 2007.

The proposed geotechnical locations include the Sivulliq prospect and the Pt. Thomson to Sivulliq prospective pipeline access corridor (Figure 1). Further definition of the investigation locations and survey areas will be made following interpretation of geophysical information collected during the 2006 open water season.

3. Species and numbers of marine mammals in area:

The species and numbers of marine mammals likely to be found within this portion of the Beaufort Sea are listed in Table 4-1.

A total of three cetacean species (bowhead, gray, and beluga whale), three species of pinnipeds (ringed, spotted, and bearded seal), and one marine carnivore (polar bear) are known to occur in or near the proposed drilling areas. Other extralimital species that occasionally occur in very small numbers in this portion of the Alaskan Beaufort Sea include the harbor porpoise and killer whale, however, because of their rarity in this area, they are not expected to be exposed to or affected by any activities associated with the drilling, and are not discussed further.

Of the potentially affected species listed above, only the bowhead whale is listed as “Endangered” under the Endangered Species Act (ESA). Other ESA-listed species, which are known to occur in the adjacent Bering Sea include Steller sea lion, sperm whale, humpback whale, fin whale, blue whale, and northern right whale; however, these species are considered to be extralimital in the Chukchi and Beaufort Seas. Due to the very remote chance of interaction or potential impact, these species are not discussed further under this IHA application.

In an effort to reduce redundancy, we have included the required information about these species and abundance estimations (to the extent known) of these species in Section 4 below.

4. Status, distribution and seasonal distribution of affected species or stocks of marine mammals:

The following six species of cetaceans and seals can be expected to occur in the region of the proposed drilling activity: bowhead, gray and beluga whales, and ringed, spotted and bearded seals. These six species are the species for which general regulations governing potential incidental takes of small numbers of marine mammals are sought. The geographic boundaries and distribution, primary habitats, and population trends and risks are discussed under each species.

Three species of marine mammals—the Pacific walrus, sea otter, and polar bear—are managed by the U.S. Fish and Wildlife Service (USFWS). Within the project activity area, only the polar bear is known to occur in significant numbers and potential incidental take of this species will be dealt with under a separate application for a Letter of Authorization (LOA) from the USFWS; however, general status information on polar bear is included in Table 4-1 but not discussed further under the species discussions.

Table 4-1 Species that May be Encountered During Activities

A list of species that may be encountered during activities within the Beaufort Sea, including their habitats, conservation status, and estimated abundance numbers.

Species (Stock)	Habitat	Beaufort Sea Stock and/or ESA Status [1]	Estimated Abundance [2]
Cetaceans			
bowhead whale (*Balaena mysticetus*) (Western Arctic stock)	Pack ice and coastal	ESA listed as Endangered, listed as depleted under MMPA, and classified as a strategic stock	10,545
gray whale (*Eschrichtius robustus*) (eastern north Pacific)	Coastal, lagoons	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	18,813
beluga whale (*Delphinapterus leucas*) (Beaufort Sea/eastern Chukchi Sea)	Offshore, coastal, ice edges	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	39,258/3,710
Pinnipeds			
ringed seal (*Phoca hispida*) (Alaska)	Landfast and pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Up to 3.6 million; Currently, no reliable abundance estimate is available for the Beaufort Sea, however, combined with surveys from the Chukchi Sea, approximately 249,000 are estimated.
spotted seal (*Phoca largha*)	Pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Several thousand and several tens of thousands. An estimate with correction using 1992 data =59,214 seals but is preliminary at best.
bearded seal (*Erignathus barbatus*)	Pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Currently, no reliable abundance estimate is available for this stock. Early estimates of the Bering-Chukchi Seas ranged from 250,000 to 300,000.
Carnivora			
polar bear (*Ursus maritimus*)	Coastal, ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Population estimates for the Southern Beaufort Sea population of northern Alaska is 2,272 bears.

1. ESA = Endangered Species Act. Stocks listed as depleted under the MMPA (Marine Mammal Protection Act) is described as any stock that falls below its optimum sustainable population (OSP) must be classified as “depleted,” 16 U.S.C. § 1362(1)(A). The numeric threshold for OSP has been interpreted by NMFS and USFWS as being above 0.6 K (i.e. greater than 60 percent of K, or carrying capacity). In other words, a stock that dropped in numbers to below 60 percent of K would qualify as “depleted” under the MMPA. The term “strategic stock” is defined as a marine mammal stock: (A) for which the level of direct human-caused mortality exceeds the Potential Biological Removal level; (B) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA of 1973 . . . within the foreseeable future; or (C) which is listed as a threatened species or endangered species under the ESA of 1973 . . ., or is designated as depleted under [the MMPA].
2. See text under individual species for population estimate sources.

Bowhead Whale (*Balaena mysticetus*)

The Western Arctic stock (discussed below) is distributed in seasonally ice-covered waters of the Arctic and near-arctic, generally between 60 and 75 degrees N latitudes in the western Arctic Basin (Moore and Reeves 1993). Currently, five bowhead whale stocks are recognized by the International Whaling Commission (IWC 1992). Small stocks occur in the Canadian Arctic and West Greenland (Baffin Bay, Davis Strait, and Hudson Bay), the Okhotsk Sea (eastern Russia), and the Northeast Atlantic from Spitzbergen westward to eastern Greenland (Zeh et al. 1993). The largest population is the Western Arctic stock, also know as the Bering, Chukchi, and Beaufort Sea stock (Rugh et al. 2003), and is the focus of this IHA.

In Alaskan waters, the majority of bowhead whales winter in the central and northwestern Bering Sea (November to March), migrate through the Chukchi Sea in the spring (March through June) following offshore ice leads around the coast of Alaska, and summer in the Canadian Beaufort Sea (mid-May through September) (Braham et al. 1980; Moore and Reeves 1993).

Bowheads tend to migrate west in deeper water (farther offshore) during years with higher-than average ice coverage than in years with less ice (Moore 2000). During fall migration, most bowheads migrate west in water ranging from 15 to 200 m deep (Miller et al. 2002 *in* Richardson and Thomson 2002); some individuals enter shallower water, particularly in light ice years, but very few whales are ever seen shoreward of the barrier islands.

Bowhead whales typically reach the Barrow area during their westward migration from the feeding grounds in the Canadian Beaufort Sea in mid-September to late-October. Although, over the years, local residents report having seen a small number of bowhead whales feeding off Barrow or in the pack-ice off Barrow during the summer, indicating that this area may be an important feeding area. Autumn bowhead whaling near Barrow normally begins in mid-September, but may begin as early as August if whales are observed and ice conditions are favorable (USDOI/BLM 2005). Whaling can continue into October, depending on the quota and conditions.

The pre-exploitation population of bowhead whales in the Bering, Chukchi, and Beaufort seas is estimated to be 10,400 to 23,000 whales, and was reduced by commercial whaling to perhaps 3,000 (Woodby and Botkin 1993). Up to the early 1990s, the population size was believed to be increasing at a rate of about 3.2 percent per year (Zeh et al. 1996; Angliss and Lodge 2002) despite annual subsistence harvests of 14 to 74 bowheads from 1973 to 1997 (Suydam et al. 1995) and 42, 35, 49, 37, and 35 in 1999 through 2003, respectively (Suydam and George 2004). This is consistent with an annual population growth rate of 3.4 percent (95 percent CL 1.7-5 percent) from 1978 to 2001 reported by George et al. (2004) who estimated the population in 2001 at approximately 10,470 animals. Based on the most recent abundance estimates using 2001 data, approximately 10,545 bowheads whales make up the Western Arctic stock, with a minimum estimate [coefficient of variation [CV](N) = 0.128] of 9,472 whales (Angliss and Outlaw 2005).

The inclusion of the abundance estimate for 2001 results in a rate of increase of 3.5 percent (confidence intervals [CI] = 2.2 to 4.9 percent) (Brandon and Wade 2004 *cited in* Angliss and Outlaw 2005). Calve counts in 2001 was the highest recorded at 121 individuals, and lends building evidence of a growing population.

This bowhead population is currently listed as Endangered under the ESA and is classified as a strategic stock by NMFS (Angliss and Outlaw 2005).

Gray Whale (*Eschrichtius robustus*)

Gray whales originally inhabited both the North Atlantic and North Pacific oceans. The Atlantic populations are believed to have become extinct by the early 1700s, while a relic population survives in the western North Pacific. The eastern North Pacific or California gray whale population has recovered significantly from commercial whaling, and now numbers about 18,813, and this stock is the focus for this IHA (Angliss and Outlaw 2005).

The eastern North Pacific population of the gray whale ranges from the Bering, Chukchi, and Beaufort Seas (in summer) to the Gulf of California (in winter) (Rice 1998). Gray whales have also been documented foraging during summer in waters off of Southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971; Berzin 1984; Darling 1984; Quan 2000; Calambokidis et al. 2002). Most of the eastern North Pacific population migrates annually from Alaska waters to Baja California in Mexico, more than 8,000 kilometers (km) (5,000 miles [mi]) roundtrip. From late-May to early-October, the majority of the population concentrates in the northern and western Bering Sea and the Chukchi Sea.

Gray whales are found primarily in shallow water, and usually remain closer to shore than any other large cetacean. Gray whales are considered common in the nearshore waters of the eastern Chukchi Sea, and occasionally are seen east of Point Barrow in late-spring and summer. On wintering grounds, mainly along the west coast of Baja California, gray whales utilize shallow, nearly land-locked lagoons and bays (Rice et al. 1981). From late-February to June, the population migrates back to arctic and subarctic seas (Rice and Wolman 1971).

Most summering gray whales congregate in the northern Bering Sea, particularly off St. Lawrence Island and in the Chirikov Basin (Moore et al. 2000b & c), and in the southern Chukchi Sea. More recently, Moore et al. (2003) suggested that gray whale use of Chirikov Basin was reduced, likely as a result of the combined effects of changing currents resulting in altered secondary productivity dominated by lower quality food. The northeastern-most of the recurring feeding areas is in the northeastern Chukchi Sea southwest of Barrow (Clarke et al. 1989).

A small number gray whales has been observed entering the Beaufort Sea east of Point Barrow. Maher (1960) reported hunters at Cross Island took one gray whale in 1933. Aerial surveys conducted in the central Alaskan Beaufort Sea documented only one gray whale from 1979 to 1997. Since 1997, small numbers of gray whales have been documented on several occasions in the central Alaskan Beaufort—mainly in the Harrison Bay area (Miller et al. 1999; Treacy 2000). Other reports of single gray whale sightings have been documented farther east of Harrison Bay (Rugh and Fraker 1981). In August 2001, Williams and Coltrane (2002) reported a single sighting of a gray whale near the Northstar production facility, indicating that small numbers do travel through the waters offshore from the Prudhoe Bay region during some summers. Given their rare occurrence in the eastern portion of the Beaufort Sea in summer, no more than a few are expected during the summer and early fall.

Gray whales have been counted as they migrate southward past Granite Canyon in central California each year since 1967. The most recent abundance estimates are from southbound migration counts in 1997/98, 2000/01, and 2001/02 periods with abundance estimates for the aforementioned periods of 29,758, 19,448, and 18,178, respectively (Rugh et al. [in press] *in* Angliss and Outlaw 2005).

Previous variations in estimates may be attributed to differences in the proportion of the gray whale stock migrating as far as the central California coast each year. The decline in abundance estimates between 2000/01, and 2001/02 may be an indication that the abundance was responding to environmental limitations as the population approaches carrying capacity (Angliss and Outlaw 2005). The lower counts conducted in 2000/01 and 2001/02 may have been due to a large number of whales that did not migrate as far south as Granite Canyon, or possibly, abundance may have actually declined following high mortality rates documented in 1999 and 2000 (Rugh et al. [in press] *cited in* Angliss and Outlaw 2005; Gulland et al. 2005).

Using the mean of the 2000/01 and 2001/02 abundance estimates noted above is 18,813 animals (Angliss and Outlaw 2005). Gray whale numbers increased steadily until at least 1998, with an estimated annual growth rate of 3.3 percent between 1967 and 1988 (Buckland et al. 1993). More recent estimated growth rates from 1967/68 through 2001/02 indicate and annual growth rate of 1.9 percent (SE = 0.32 percent) (Rugh et al. [In press] *in* Angliss and Outlaw 2005). In addition, Rugh et al. (in press) estimated carrying capacity of 26,290 (CV = 0.059), indicating that recent reductions in abundance estimates may be a function of the population reaching its carrying capacity.

The eastern Pacific stock was removed from the Endangered Species List in 1994 and is not considered by NMFS to be a strategic stock.

Beluga Whale (*Delphinapterus leucas*)

The beluga whale is an Arctic and subarctic species with several populations (stocks) occurring in Alaska: Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet (O'Corry-Crowe et al. 1997, Angliss and Lodge 2004). For the proposed project, only the Beaufort Sea stock and eastern Chukchi Sea stocks will be encountered. Some eastern Chukchi Sea animals enter the Beaufort Sea in late summer (Suydam et al. 2001).

Beluga whales of the Beaufort stock winter in the Bering Sea, summer in the eastern Beaufort Sea, and migrate around western and northern Alaska (Angliss and Lodge 2002). The majority of belugas in the Beaufort stock migrate into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late March and as late as July (Braham et al. 1984; Ljungblad et al. 1984; Richardson et al. 1995).

Much of the Beaufort Sea seasonal population enters in the Mackenzie River estuary for a short period during July and August to molt their epidermis, but they spend most of the summer in offshore waters of the eastern Beaufort Sea and Amundsen Gulf (Davis and Evans 1982; Harwood et al. 1996). Belugas are rarely seen in the central Alaskan Beaufort Sea during the summer. During late summer and autumn, most belugas migrate far offshore near the pack ice front (Hazard 1988; Clarke et al. 1993; Miller et al. 1998) and may select deeper slope water independent of ice cover (Moore et al. 2000b). Small numbers of belugas are sometimes observed near the north coast of Alaska during the westward migration in late-summer and autumn (Johnson 1979) but the main fall migration corridor of beluga whales is greater than 100 km (62 mi) north of the coast. Aerial- and vessel-based seismic monitoring programs conducted in the central Alaskan Beaufort Sea from 1996 through 2001 observed only a few beluga whales migrating along or near the coast (LGL and Greeneridge 1996; Miller et al. 1998, 1999). The vast majority of belugas seen during those projects were far offshore. Satellite-linked telemetry data show that some belugas migrate west considerably farther offshore, as far north as 78 degrees N latitude (Richard et al. 1997, 2001).

The Beaufort population was estimated to contain 39,258 individuals as of 1992 (Angliss and Lodge 2002). This estimate is based on the application of a sightability correction factor of 2 times to the 1992 uncorrected census of 19,629 individuals made by Harwood et al. (1996). This estimate was obtained from a partial survey of the known range of the Beaufort population and may be an underestimate of the true population size. This population is not considered by NMFS to be a strategic stock but the current population trend of the Beaufort Sea stock of beluga whales is unknown (Angliss and Outlaw 2005).

The abundance estimate considered the “most reliable” for the eastern Chukchi Sea beluga whale stock is 3,710, a result from 1989–1991 aerial surveys (Frost et al. 1993, Angliss and Lodge 2004). Additional surveys were conducted in 1998 (DeMaster et al. 1998) and again in July 2002 (Lowry and Frost 2002, *cited in* Angliss and Outlaw 2005), but both were partial surveys and therefore, a more recent abundance estimate is not available.

This stock will not likely be encountered during the drilling in the eastern Beaufort Sea. The population size is considered stable and not considered to be a strategic stock.

Ringed Seal (*Phoca hispida*)

In the North Pacific, ringed seals are found in the southern Bering Sea and range as far south as the Seas of Okhotsk and Japan. Ringed seals have an affinity for ice-covered waters and are well adapted to occupying seasonal and permanent ice, and are year-round residents throughout the Beaufort, Chukchi, and Bering Seas, as far south as Bristol Bay in years of extensive ice coverage. They tend to prefer large floes (more than 48 m in diameter) and are often found in the interior ice pack where the sea ice coverage is greater than 90 percent (Simpkins et al. 2003), and remain in contact with ice most of the year and pup on the ice in late winter - early spring.

During winter, ringed seals occupy landfast ice and offshore pack ice of the Bering, Chukchi, and Beaufort Seas. Ringed seals maintain breathing holes in the ice and occupy lairs in accumulated snow (Smith and Stirling 1975). They give birth in lairs from mid-March through April, nurse their pups in the lairs for 5–8 weeks, and mate in late-April and May (Smith 1973; Hammill et al. 1991; Lydersen and Hammill 1993).

During late-April through June, ringed seals are distributed throughout their range from the southern ice edge northward (Braham et al. 1984). Preliminary results from recent surveys conducted in the Chukchi Sea in May-June 1999 and 2000 indicate that ringed seal density is higher in nearshore fast and pack ice, and lower in offshore pack ice (Bengtson et al. (2005) *cited in* Angliss and Outlaw 2005). Frost and Lowry (1999) conducted surveys in May and results indicated that, in the Alaskan Beaufort Sea, the density of ringed seals in May-June is greater to the east of Flaxman Island than to the west.

No estimate for the size of the Alaska ringed seal stock is currently available (Angliss and Outlaw 2005). Past ringed seal population estimates in the Bering-Chukchi-Beaufort area ranged from 1 to 3.6 million (Frost et al. 1988). Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter.

Aerial surveys within 20 nautical miles (nm) of shore were conducted in May-June between 1986 and 1987 for a portion of the range of the ringed seal estimated a population of 44,360 +/-9,130 (96 percent CI) (Frost et al. 1988). Spring density estimates in the same area from 1985-1987 ranged from 1.01 to 2.94 seals/square kilometers (km^2)(Frost et al. 1988). Similar surveys for the Alaska Beaufort Sea between Kaktovik and Barrow occurred in the spring during several years in the 1990s with density estimates for all years ranging from 0.81-1.17 seals/km^2 with a mean of 0.98 seals/km^2 or approximately 18,000 hauled out ringed seals in the survey area. Surveys conducted in 1999 and 2000 between Shishmaref to Barrow in the eastern Chukchi Sea estimated abundance of ringed seals at 252,488 (SE = 47,204) and 208,857 (SE = 25,502), respectively (Bengtson et al. (2005) *cited in* Angliss and Outlaw 2005). Combining the numbers of Alaska Beaufort Sea ringed seals with the average abundance estimate of 230,673 seals from the eastern Chukchi Sea, results in a total of 249,000 seals.

It is not known whether the more recent lower densities correspond to an actual reduction in the population or are related to earlier survey dates in 1990s. At earlier dates, a higher proportion of the seals are still using their lairs and are unavailable to be counted by aerial surveyors (Kelly et al. 2005). Frost et al. (2002) reanalyzed the earlier estimates for 1985-87 and reported ringed seal densities surveyed between Oliktok Point and Flaxman Island ranged from 0.56 to 1.16 seals/km^2 (about half the density originally reported) during the spring seasons of 1985 to 1987. Based on more recent surveys from 1996 through 1999, ringed seal density in fast-ice areas between Oliktok Point and Flaxman Island ranged from 0.48 to 0.77 seals/km^2 (Frost et al. 2002).

BP's Northstar project, located near Prudhoe Bay, developed a seal survey and monitoring program to establish a baseline prior to construction and to monitor during initial operations for comparison. Ringed seal densities reported by Moulton et al. (2002) ranged from 0.39 to 0.63 seals/km^2 prior to construction in the Northstar development area. Ringed seal densities close to Northstar in 2000, 2001, and 2002 were not reduced relative to those farther away or to those during the 1997 to 1999 pre-development period (Moulton et al. 2003 a, b); however, because aerial surveys will underestimate actual seal densities, the above density figures should be used as minimum estimates.

During summer, ringed seals are found dispersed throughout open water areas, although in some regions they move into coastal areas (Smith 1987; Harwood and Stirling 1992). During the open water period, ringed seals in the eastern Beaufort Sea are widely dispersed as single animals or small groups (Harwood and Stirling 1992). Marine mammal monitoring in the nearshore central Beaufort Sea confirms these generalities (Moulton and Lawson 2002; Williams et al. 2004).

Large concentrations of ringed seals are not expected to be encountered during the summer and autumn drilling period. The Alaska stock of ringed seals is not classified as a strategic stock by the NMFS.

Spotted Seal (*Phoca largha*)

Spotted seals occur in the Beaufort, Chukchi, Bering and Okhotsk Seas, and south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). Based on satellite tagging studies, spotted seals migrate south from the Chukchi Sea in October and pass through the Bering Strait in November and overwinter in the Bering Sea along the ice edge (Lowry et al. 1998).

During spring when pupping, breeding and molting occur, spotted seals tend to prefer small floes (less than 20 m in diameter), and inhabit mainly the southern margin of the ice in the Okhotsk and Bering Seas, with movement to coastal habitats after the retreat of the sea ice (Shaughnessy and Fay 1977; Quakenbush 1988; Rugh et al. 1997; Simpkins et al. 2003).

In summer, the majority of spotted seals are found in the Bering and Chukchi Seas, but do range into the Beaufort Sea (Rugh et al. 1997; Lowry et al. 1998) from July until September. At this time of year, spotted seals haul out on land part of the time, but also spend extended periods at sea. The seals are most commonly seen in bays, lagoons, and estuaries and are typically not associated with pack ice unless it is near to shore.

A small number of spotted seal haul-outs are documented in the central Beaufort Sea near the deltas of the Colville River and, previously, the Sagavanirktok River. Historically, these sites supported as many as 400 to 600 spotted seals, but in recent times less than 20 seals have been seen at any one site (Johnson et al. 1999).

As the ice cover thickens with the onset of winter, spotted seals leave the northern portions of their range and move into the Bering Sea (Lowry et al. 1998).

Previous studies from 1996 to 2001 indicate that few spotted seals (a few tens) utilize the central Alaskan Beaufort Sea (Moulton and Lawson 2002; Treacy 2002 a, b). In total, there are probably no more than a few tens of spotted seals along the coast of the central Alaska Beaufort Sea during summer and early fall with very few, if any, occurring in the eastern portion of the Beaufort Sea.

A reliable abundance estimate for spotted seal is not currently available (Angliss and Outlaw 2005), however, early estimates of the size of the world population of spotted seals was 335,000 to 450,000 animals and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000–250,000 animals (Burns 1973 *cited in* Angliss and Lodge 2004). The total number of spotted seals in Alaskan waters is not known (Angliss and Lodge 2004), but the estimate is most likely between several thousand and several tens of thousands (Rugh et al. 1997). Using maximum counts at known haul-outs from 1992 (4,135 seals), and a preliminary correction factor for missed seals developed by the Alaska Department of Fish and Game (Lowry et al. 1994), an abundance estimate of 59,214 was calculated for the Alaska stock (Angliss and Lodge 2004).

The activities associated with the proposed drilling program in the Beaufort Sea are expected to encounter few to no spotted seals. The Alaska stock of spotted seals is not classified as a strategic stock by NMFS.

Bearded Seal (*Erignathus barbatus*)

Bearded seals are associated with sea ice and have a circumpolar distribution (Burns 1981). Bearded seals are predominately benthic feeders, and prefer waters less than 200 m in depth.

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter they are most common in broken pack ice and in some areas also inhabit shorefast ice (Smith and Hammill 1981). In Alaska waters, bearded seals are distributed over the continental shelf of the Bering, Chukchi, and Beaufort Seas, but are more concentrated in the northern part of the Bering Sea from January to April (Burns 1981).

During winter, most bearded seals in Alaskan waters are found in the Bering Sea. In the Chukchi and Beaufort Seas, favorable conditions are more limited, and consequently, bearded seals are less abundant there during winter. From mid- to late-April to June, as the ice recedes, some of the bearded seals migrate northward through the Bering Strait and spend the summer along the ice edge in the Chukchi Sea (Burns 1967; Burns 1981).

Recent spring surveys along the Alaskan coast indicate that bearded seals tend to prefer areas of between 70 and 90 percent sea-ice coverage, and are typically more abundant greater than 20 nm of shore, with the exception of high concentrations nearshore to the south of Kivalina in the Chukchi Sea (Bengtson et al. 2000; Simpkins et al. 2003).

During the summer in the Chukchi Sea, bearded seals are most associated with the pack ice edge near the continental shelf. The nearshore areas of the central and western Beaufort Sea provide somewhat more limited habitat because the continental shelf is narrower and the pack ice edge frequently occurs seaward of the shelf and over waters greater than 200 m in depth. The preferred habitat in the Beaufort Sea during the open water period is the continental shelf seaward of the scour zone.

A reliable abundance estimate for the Alaska stock of bearded seals is currently not available. The most recent surveys occurred in May-June of 1999 and 2000 between Shishmaref and Barrow with average densities of 0.07 seals per km^2 and 0.14 seals per km^2, respectively, however, there is no correction factor available for these data. Early estimates of the Bering-Chukchi Sea population ranged from 250,000 to 300,000 (Burns 1981).

No reliable estimate of bearded seal abundance is available for the Beaufort Sea (Angliss and Lodge 2002). Aerial surveys conducted by MMS in fall 2000 and 2001 sighted a total of 46 bearded seals during survey flights conducted between September and October (Treacy 2002 a, b), with all but two sightings recorded east of 147 degrees W and all sightings were within 40 nm of shore. Aerial surveys conducted from 1997 to 2002 in the vicinity of Northstar Island also reported small numbers (up to 15) of bearded seals (Moulton et al. 2003c).

The proposed drilling program may encounter bearded seals during the open-water season, however, the number of bearded seals is expected to be small. The Alaska stock of bearded seals is not classified by NMFS as a strategic stock.

5. The type of incidental taking authorization that is being requested (i.e. takes by harassment only; takes by harassment, injury and /or death) and the method of incidental taking:

The only type of incidental taking sought in this application is that of takes by noise harassment. The only sources of project created noise will be those stemming from the Kulluk and Discoverer and their support vessels. Although the bulk of the activity will be centered in the area of drilling, potential exposures, or impacts to marine mammals also will occur as the drilling vessels, and ice management vessels mobilize through the Beaufort and Chukchi Seas.

Historical noise propagation studies were performed on the Kulluk (Hall et al. 1994) in the Kuvlum prospect drill sites (approximately 6 miles east of SOI's Sivulliq prospect) that SOI is proposing to drill during 2007. Acoustic recording devices were established at 10 m and 20 m depths below water surface at varying distances from the Kulluk and decibel (dB) levels were recorded during drilling operations. There were large differences between sound propagation between the different depths. At 10 m water depth, the 120 db threshold had a 0.7 km radius around the Kulluk, and the 105 db threshold was an 8.5 km radius. At depth of 20 m below water surface, the 120 db threshold had a radius of 8.5 km and the 105 db had a radius of 100 km. There is no obvious explanation for the large differences in propagation at the different levels. Possible explanations include the presence of an acoustic layer due to melting ice during the sound studies and/or sound being channeled into the lower depths due to the seafloor topography.

New sound propagation studies will be performed on the Kulluk, Discoverer, ice management, and support vessels once these vessels are on locations for drilling in the Beaufort Sea.

6. Numbers of marine mammals that may potentially be taken:

SOI seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of the NMFS in the proposed region of activity. Species for which authorization is sought are bowhead, gray, and beluga whales, and ringed, spotted, and bearded seals. Polar bears will be covered in a separate authorization pending from the USFWS.

The only anticipated impacts to marine mammals are associated with noise propagation from drilling activities and associated support vessels. Impacts would consist of temporary and short term displacement of seals and whales from within ensonified zones produced by such noise sources.

The proposed drilling activities in the Beaufort Sea proposed by SOI are not expected to "take" more than small numbers of marine mammals, or have more than a negligible effect on their populations.

Basis for Estimating Numbers of Marine Mammals that Might be "Taken by Harassment"

Taking into account the limited scope of work areas, the small radii of the 160 db and higher sound levels around the drilling and supporting vessels, and the mitigation measures that are planned, effects on cetaceans and pinnipeds are generally expected to be limited to avoidance of an area (ensonification zone) around the drilling operations and short-term changes in behavior, falling within the MMPA definition of "Level B harassment".

Cetaceans

For whales, Moore et al. (2000b and c) likely offer the most current data to estimate densities of belugas, and gray whales during summer in the Beaufort and Chukchi Seas, however, densities of beluga and gray whales are likely overestimated due to the fact that most beluga and gray whales are found west of the most highly prospective drilling area. Density estimates for bowhead whale were derived from surveys conducted by air during the bowhead migration (Miller et al., 2002) and, while likely accurate for the areas proposed for drilling activities within the eastern Beaufort Sea, will overestimate the numbers of "take by harassment" (noise disturbance) because activities also will occur when bowhead whales are not present.

Table 6-1 gives the average and maximum densities for each cetacean species likely to occur within the project areas. All drilling activities will occur in waters between 20 and 40 m in depth.

The estimated numbers of potential exposures presented in Table 6-1 are based on the 160 dB re 1 μPa (rms) criteria for most cetaceans, because this range is assumed to be the sound source level at which marine mammals may change their behavior sufficiently to be considered "taken by harassment."

Pinnipeds

Ringed, spotted, and bearded seals are all associated with sea ice, and most census methods used to determine density estimates for pinnipeds are associated with counting the number of seals hauled out on ice.

Table 6-1 Expected Densities of Marine Mammals

Expected densities of marine mammals during open-water drilling program proposed for offshore areas of the Beaufort Sea.

Species	Average Density (#/km^2) [1]	Maximum Density (#/km^2) [1]
Cetaceans		
bowhead whale	0.0064	0.0256
gray whale	0.0001	.0004
beluga whale	0.0068	.0135
harbor porpoise	0.0000	.0002
Pinnipeds		
ringed seal	0.3547	.7094
spotted seal	0.0037	.0149
bearded seal	0.0181	.0362

1. These estimates are calculated from various sources including Moore et al. 2000b & c, Stirling et al. 1982, Kingsley 1986, and presented in LGL 2005, Table 4.

Correction factors have been developed for most pinniped species that address biases associated with detectability and availability of a particular species. Although extensive surveys of ringed and bearded seals have been conducted in the Beaufort Sea, the majority of the surveys have been conducted over the landfast ice and few seal surveys have been in open water. The most comprehensive survey dataset on ringed seals (and bearded seal) from the central and eastern Beaufort Sea was conducted on offshore pack ice in late spring (Kingsley 1986). It is important to note that all proposed activities will be conducted during the open-water season and density estimates used here were based on counts of seals on ice. Therefore, densities and potential take numbers will overestimate the numbers of seals that would likely be encountered and/or exposed because only the animals in the water would be exposed to the drilling sound sources.

Although the estimated numbers of potential exposures presented in Table 6-1 are based on two sound source ranges (greater than 160 dB and greater than_170 dB re 1 μPa [rms]), for most pinnipeds, the 170 dB threshold should be used to determine "take by harassment" because this range is assumed to be the sound source level at which most pinnipeds may change their behavior in reaction to increased sound exposure.

Exposure Calculations for Bowhead Whales

Estimation of exposures of bowhead whales to sound levels that may produce behavioral responses utilized a total population estimate of 12,888 individuals from Zeh and Punt (2005). Sound propagation estimates were derived for the 160 dB level by deriving the most conservative estimate of sound propagation of drilling related activities from LGL and Greenridge (1987) and Hall et al. (1994). These latter references also form the basis of similar estimates of sound propagation of drilling operations as reviewed by Richardson et al. 1995.

The proportion of bowhead whales that might occur within the area potentially ensonified by the 160 and 120 dB criterion were estimated from Richardson and Thomson (2002) in which average migrating distribution across the 0-20, 20-40, 40-200 and >200 meter isopleths are estimated to be 25, 27, 37, and 10 percent of the population respectively. As the majority of the operations related to the 2007 drilling program will occur within the 20-40 m depth isopleth, it is estimated that the average expected number of bowheads in this area would be 0.27 x 12,888 or 3,480. As a conservative estimate of potential bowheads present the expected number was taken times two for a maximum estimate of 6,960 individuals.

No measured sound levels from either LGL and Greeneridge (1987) or Hall et al. (1994) exceeded 160 dB. Hall et al.; however, utilized measurements from sonobuoys deployed at distances of 20, 27, and 34 km from active drilling operations to estimate that combined activities including drilling, geotechnical boring, vessel transit, and ice management activities may reach 160 dB at a distance of 200 m from the source (Figure 6.1). Although no single source produced measured sound in excess of 160 dB, this 200 m distance was selected as a conservative estimate of potential sound propagation from drilling related sources. Although planned operating procedures will limit the number of sound sources that will be operating during any portion of the bowhead migration (e.g. spill response vessels will be on anchor and minimally active) the additional conservative assumption is made that 10 sources could simultaneously operate at a level to cumulatively produce 160 dB at 200 m. The total ensonified (at 160 dB) area under this scenario would be 2 km, or approximately 7 % of the 29 km wide 20-40 m isopleth.

Seven percent of the bowhead whales present in the 20-40 m isopleth would be 244 as an average estimate and 488 as a maximum estimate.

NMFS requested SOI prepare estimation of exposures to the level of 120 dB. Although the biological significance of this 120 dB sound level is subject to debate, several studies report that migrating bowhead whales react to and, possibly avoid, sound levels in excess of 120 dB. As such, estimation of exposures to 120 dB levels is included in this discussion.

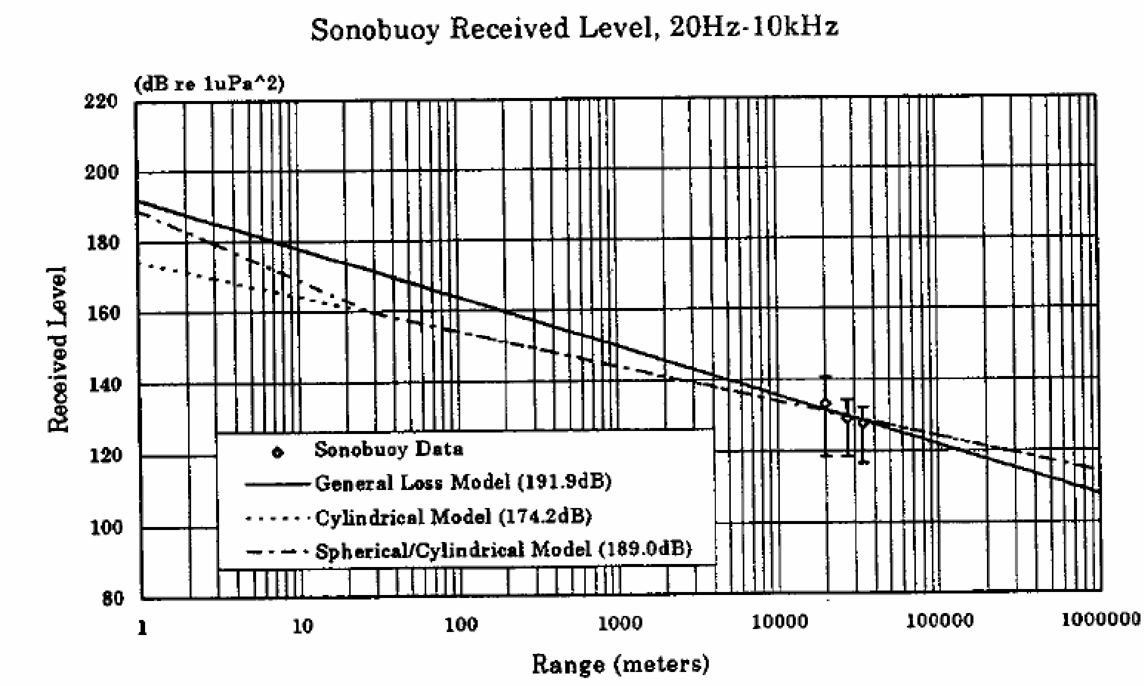


Figure 6.1 Measured and predicted distances of ensonification by combined drilling and support activities (from Hall et al. 1994)

One difficulty with what may be referred to as the 120 dB criterion is an inconsistency between field observations of migrating bowhead avoidance behavior associated with sound measurements and sound measurements and modeling that is independent of whale observations. The majority of observations upon which the 120 dB criterion are based are derived from aerial monitoring programs around both drilling and seismic sources. Closest observed proximity of bowhead whales to operating drilling or icebreaking operations vary between 3 km (Hall et al., 1994), 11 km (LGL & Greeneridge, 1987) and 19 km (Ljungblad et al. (1987). There is some consistency, however, in estimation of the distance of deflection from drilling/ice management activities being in the range of 10-20 km from the source. Sound measurements acquired in the proximity of observed whales tend to be approximately 120 dB leading to the conclusion that migrating bowheads tend to avoid sound levels in excess of 120 dB (Richardson et al., 1995). Similar conclusions have been drawn from observations around operating seismic vessels (LGL, 2005).

Projection of sound propagation from measurements of sound around drilling operations and seismic operations and modeled sound propagation (Hall et al., 1994) tend to yield estimations of the 120 dB isopleth to be well beyond the 20 km distance. For example, Hall et al. (1994) estimated the 120 dB isopleth for combined drilling/ice management operations to be in excess of 100 km from the source(s). While subsistence hunters report changes in migrating bowhead whale behavior at distance as far as 35 miles from operating seismic vessels, extrapolation of avoidance to greater distances is not generally reported.

For the purpose of this estimation of relevant exposures, a reasonably conservative distance of 30 km zone of potential exposure around drilling operations would produce exposures within the 0-

20, 20-40, and 40-200 m depth zones. It is possible that exposures to sound levels in excess of 120 dB could be experienced by as much as 65 % of the population (8,378 individuals).

Exposure Calculations for Other Cetaceans and Pinnipeds.

For all other species, average expected abundance was estimated by multiplying the reported densities (Table 6-1) for each species times a potential operational area of 840 km^2 (operational = the area in which primary drilling activities will occur, i.e. 29 km width of the 20 – 40 m depth isopleth squared). Maximum expected abundances for all species were estimated by multiplying average expected abundance times two. Average and expected exposures were then calculated by multiplying the abundance time the expected portion of the operational area expected to be ensonified greater than 160 dB (i.e. 0.069).

Table 6-2 Exposure Calculations for Cetaceans and Pinnipeds

Estimates of possible numbers of marine mammals exposures to 160 dB during SOI's proposed drilling program in the Beaufort Sea.

	Average Expected Abundance	Average Expected Exposures in 160 dB range	Maximum Expected Abundance	Maximum Expected Exposures in 160 dB range	Requested Take Authorization
Cetaceans					
bowhead whales	3479.76	244	6959,52	488	488
gray whale	0.083916	1	0.335662	1	1
beluga	5.706262	1	11.32861	1	1
harbor porpoise		0	0.167831	1	1
		0			
Pinnipeds		0			
ringed seal	297.6487	21	595.2974	42	42
spotted seal	3.104878	1	12.50343	1	1
bearded seal	15.18873	2	30.37745	3	3

Average expected abundances for bowhead whales were derived from the Miller et al. (2002) feeding study in which total proportion of the population "moving through" was estimated for the depth isopleths in which drilling operations are expected to occur. For all other species, average expected abundance was estimated by multiplying the reported densities (Table 6-2) for each species times a potential operational area of 840 km^2. The operational area includes activities conducted by the drilling units, geotechnical drill ship and support vessels. Maximum expected abundances for all species were estimated by multiplying average expected abundance times two. Average and expected exposures were then calculated by multiplying the abundance times the expected portion of the operational area expected to be ensonified greater than 160 dB (i.e. 0.069).

The last column of Table 6-2 also shows the shows the numbers of animals for which "harassment take authorization" is requested. No other cetacean or pinniped species are suspected to occur within the eastern portion of the Beaufort Sea and are not included under this IHA because of the unlikely event of an encounter. The results and estimated request for take authorization is displayed in Table 6-2.

Ringed seals would be the most prevalent marine mammal species encountered at each of the two proposed drilling areas. Pinnipeds are not likely to react to sounds unless they are ≥170 dB re 1 μPa (rms), and Moulton and Lawson (2002) indicated that most pinnipeds exposed to 170 dB do not visibly react. Under this IHA, the requested take authorization for all pinnipeds uses the maximum density between 170 and 179 dB instead of the 160 dB threshold. This decision to use the lower estimated number is based on the theory that surveys for pinnipeds within the Beaufort Sea, and elsewhere, are based on on-ice counts which will overestimate the number of potential exposures (i.e., only a portion of the animals are in the water, and therefore, could be exposed).

Spotted and bearded seals may be encountered in much small numbers than ringed seals, but also have the potential for exposure.

Effects on polar bears are anticipated to be minor at most. No estimate of polar bears that may be harassed by noise associated with drilling activities are given, however this species will be addressed under a letter of authorization with the USFWS.

Summary

The proposed drilling program in the Beaufort Sea will involve two drilling units separated by approximately 50 miles. Each drilling unit will drill approximately two wells, with each set of 2-4 holes within a small aerial extent. Taking into account the relatively low sound output of the drilling sources, and mitigation measures that are planned, effects on cetaceans and pinnipeds are generally expected to be limited to avoidance of a small area around the drill site and short-term changes in behavior, falling within the MMPA definition of “Level B harassment”. The requested “take authorization” for each species is based on the estimated *maximum number of exposures* to greater than or equal to 160 dB re 1 μPa (rms) for all cetaceans and pinnipeds (i.e., the highest of the various estimates where a behavioral change may be expected). In addition, the estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are very low percentages of the population sizes in the Beaufort Sea.

7. The anticipated impact of the activity on the species or stock:

The only anticipated impacts to marine mammals associated with drilling activities are with respect to noise propagation from the drilling units and associated support vessels. The impacts would be temporary and result in only short term displacement of seals and whales from within ensonified zones produced by such noise sources. Any impacts on the whale and seal populations of the Beaufort Sea activity area are likely to be short term and transitory arising from the temporary displacement of individuals or small groups from locations they may occupy at the times they are exposed to drilling sounds at the 160-190 db received levels. As noted in Section 6, above, it is highly unlikely that animals will be exposed to sounds of such intensity and duration as to physically damage their auditory mechanisms. In the case of bowhead whales that displacement might well take the form of a deflection of the swim paths of migrating bowheads away from (seaward of) received noise levels greater than 160 db (Richardson et al. 1999). The cited and other studies conducted to test the hypothesis of the deflection response of bowheads have determined that bowheads return to the swim paths they were following at relatively short distances after their exposure to the received sounds. There is no evidence that bowheads so exposed have incurred injury to their auditory mechanisms. Additionally, there is no conclusive evidence that exposure to sounds exceeding 160 db have displaced bowheads from feeding activity (Richardson, W.J and D.H. Thomson [eds]. 2002).

There is no evidence that seals are more than temporarily displaced from ensonified zones and no evidence that seals have experienced physical damage to their auditory mechanisms even within ensonified zones.

8. The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses:

There could be an adverse impact on the Inupiat bowhead subsistence hunt if the whales were deflected seaward (further from shore) in the traditional hunting areas north of Pt. Thomson in Camden Bay. The impact would be that whaling crews would necessarily be forced to travel greater distances to intercept westward migrating whales thereby creating a safety hazard for whaling crews and/or limiting chances of successfully striking and landing bowheads. This potential impact is mitigated by application of the procedures established in the drilling CAA between the SOI, the AEWC and the whaling captains' associations of Kaktovik, Nuiqsut and Barrow. It is proposed that SOI will design a marine mammal monitoring and mitigation plan acceptable to the AEWC and whaling captains that affords SOI the opportunity to drill through whaling season. Mitigation measures outlined in the drilling CAA will minimize any adverse effects on whales and whalers. (See Section 12, below).

There should be no adverse impacts on the availability of the whale species for subsistence uses.

9. Anticipated impact on habitat:

The proposed activities will not result in any permanent impact on habitats used by marine mammals, or to their prey sources. Any effects would be temporary and of short duration at any one place. The primary potential impacts to marine mammals are associated with elevated sound levels from drilling operations and their support vessels.

10. Anticipated impact of habitat loss or modification:

The effects of the planned drilling activities are expected to be negligible. It is estimated that only a small portion of the animals utilizing the areas of the proposed activities would be temporarily displaced. During the period of drilling activities (late-July or early-August through October 2007), most marine mammals would be dispersed throughout the area. The peak of the bowhead whale migration through the Beaufort Sea typically occurs in October, and efforts to reduce potential impacts during this time will be addressed with the actual start of the migration and with the whaling communities. Starting in late-August, bowheads may travel in proximity to the drilling; some might be displaced seaward by the planned activities. The numbers of cetaceans and pinnipeds subject to displacement are small in relation to abundance estimates for the mammals addressed under this IHA.

In addition, feeding does not appear to be an important activity by bowheads migrating through the eastern and central part of the Alaskan Beaufort Sea in most years. In the absence of important feeding areas, the potential diversion of a small number of bowheads is not expected to have any significant or long-term consequences for individual bowheads or their population. Bowheads, gray, or beluga whales are not predicted to be excluded from any habitat.

The proposed activities are not expected to have any habitat-related effects that would produce long-term affects to marine mammals or their habitat due to the limited extent of the acquisition areas and timing of the activities.

11. The availability and feasibility (economic and technological), methods, and manner of conducting such activity or means of effecting the least practicable impact upon affected species or stock, their habitat, and of their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance:

Details of the proposed mitigations are discussed further in the Marine Mammal Monitoring and Mitigation Plan that is provided as Attachment B to this application.

12. Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

i. A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation.

ii A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation.

iii A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

iv What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

i. A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation.

Negotiations were initiated beginning September 2006 with the AEWC to create a drilling CAA between SOI, and the subsistence hunting communities of Barrow, Nuiqsut, and Kaktovik for the 2007 drilling program activities. The drilling CAA will cover both this proposed Beaufort Sea exploratory and geotechnical drilling programs. SOI and other industry participant operators, with AEWC, will attend public meetings and meet with the whaling captains in the communities of Kaktovik, Nuiqsut, and Barrow between January 29-February 1, 2007. These meetings initiate information exchanges with the communities on the potential, proposed open water seismic and drilling programs for 2007.. Additional engagements with AEWC and the whaling captains of Kaktovik, Nuiqsut, and Barrow will occur between these meetings and onset of open water activities in June/July of 2007.

Plan of Cooperation (POC) meetings occurred in Barrow and Nuiqsut on October 16 and 17, 2006, and follow-up meetings will be May or June 2007 in these communities. SOI conducted a meeting with the Kaktovik Inupiat Corporation in Kaktovik on November 28, 2006. SOI will continue efforts with public and private organizations to hold additional meetings as needed in Kaktovik during 2007. In addition to public meetings with AEWC and the whaling captains during January and February, SOI will conduct additional POC meetings in Barrow, Kaktovik and Nuiqsut subsequent to finalization of the Marine Mammal Monitoring and Mitigation plan during May and/or June 2007. Following those meetings, a POC report will be prepared.

ii <u>A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation.</u>

SOI held community meetings with the affected Beaufort Sea whaling communities of Barrow and Nuiqsut in mid-October and will hold meetings again in early 2007 as discussed above.

iii <u>A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing;</u>

The drilling CAA will incorporate all appropriate measures and procedures regarding the timing and areas of the operator’s planned activities (i.e., times and places where effects of drilling operations will be monitored and prospectively mitigated to avoid potential conflicts with active subsistence whaling and sealing); communications system between operator’s vessels and whaling and hunting crews (i.e., the communications center will be located in strategic areas); provision for marine mammal observers/Inupiat communicators aboard all project vessels; conflict resolution procedures; and provisions for rendering emergency assistance to subsistence hunting crews.

iv <u>What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.</u>

POC meetings will be held in spring 2007 in the affected communities. In addition, the applicant can meet with North Slope officials and community leaders on an as-requested basis before the open water season in order to discuss the proposed activities.

If requested, post season meetings will also be held to assess the effectiveness of the 2007 drilling CAA, to address how well conflicts (if any) were resolved; and to receive recommendations on any changes (if any) might be needed in the implementation of future CAAs.

It is anticipated that a final draft of the drilling CAA for the Beaufort Sea will be available for consideration and review by NMFS and the MMS by early spring.

13. The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on the population of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding:

The proposed Marine Mammal Monitoring and Mitigation Plan for the drilling program is included as Attachment B of this application and addresses the issues in item 13. It should be noted that all sightings of polar bears and walrus by shipboard or aerial observers will be recorded and reported to the USFWS.

14. Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects:

Marine mammal studies in the Beaufort Sea may be undertaken by various agencies and programs during the course of the 2007 open-water season. It is unclear if these studies might be relevant to SOI's proposed activities. SOI is prepared to share information obtained during implementation of our marine mammal monitoring program with a variety of groups who may find the data useful in their research. A suggested list of recipients includes:

- The NSB Department of Wildlife Management (C. George)
- The USFWS Office of Wildlife Management (C. Perham)
- The MMS's Bowhead Whale Aerial Survey Program (C. Monnett)
- The Kuukpik Subsistence Oversight Panel (KSOP)
- AEWC (Barrow)
- North Slope Science Initiative (Ken Taylor)
- The MMS Field Supervisor (Jeff Walker)

Literature Cited for Beaufort Sea Drilling IHA

<u>Sections 3, 4, 6, 9, and 10</u>

Angliss, R.P. and K.L. Lodge. 2002. *Alaska Marine Mammal Stock Assessments, 2002*. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-133, 224 p.

Angliss, R.P. and K.L. Lodge. 2004. *Alaska Marine Mammal Stock Assessments, 2003*. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-144. 230 p.

Angliss, R.P. and R. Outlaw. 2005. *Draft Marine Mammal Stock Assessment Reports (SARS) by Species/Stock.* Draft Reports 2005, revised July 2005. NMFS. AFSC Center. Seattle, WA. 229 p. Available online at: http://www.nmfs.noaa.gov/pr/readingrm/MMSARS/draft05alaskareportall.pdf

Bengtson, J.L., P.L. Boveng, L.M. Hiruki-Raring, K.L. Laidre, C. Pungowiyi, and M.A. Simpkins. 2000. *Abundance and Distribution of Ringed Seals (Phoca hispida) in the Coastal Chukchi Sea.* Pp. 149-160, In A.L. Lopez and D.P. DeMaster. Marine Mammal Protection Act and Endangered Species Act Implementation Program 1999. AFSC Processed Report 2000-11, 195 pp.

Bengtson, J.L., L.M. Hiruki-Raring, M.A. Simpkins, and P.L. Boveng. 2005. *Ringed and Bearded Seal Densities in the Eastern Chukchi Sea, 1999-2000.* Polar Biol. 28: 833-845, cited in Angliss and Outlaw 2005.

Berzin, A.A. 1984. *Soviet Studies on the Distribution and Numbers of the Gray Whale in the Bering and Chukchi Seas from 1968 to 1982.* Pp. 409-419, In M.L. Jones, S.L. Swartz, and S. Leatherwood (eds.), The Gray Whale, Eschrichtius robustus. Academic Press, Inc., Orlando. xxiv + 600 pp.

Braham, H.W., M.A. Fraker, and B.D. Krogman. 1980. *Spring Migration of the Western Arctic Population of Bowhead Whales*. Mar. Fish. Rev. 42(9-10):36-46.

Braham, H.W., B.D. Krogman and G.M. Carroll. 1984. *Bowhead and White Whale Migration, Distribution, and Abundance in the Bering, Chukchi, and Beaufort Seas, 1975-78*. NOAA Tech. Rep. NMFS SSRF-778. USDOC/NOAA/NMFS. 39 p. NTIS PB84-157908.

Brandon, J. and P.R. Wade. 2004. *Assessment of the Bering-Chukchi-Beaufort Seas Stock of Bowhead Whales.* Unpublished Report Submitted to International Whaling Commission (SC/56/BRG20). 32 pp.

Buckland, S.T., Breiwick, J.M., Cattanach, K.L. and Laake, J.L. 1993. *Estimated Population Size of the California Gray Whale. Mar. Mammal Sci.* 9(3):235-49.

Burns, J.J. 1967. *The Pacific Bearded Seal*. Alaska Department of Fish and Game, Pittman-Robertson Proj. Rep. W-6-R and W-14-R. 66 pp.

Burns, J.J. 1973. *Marine Mammal Report*. Alaska Department of Fish and Game, Pittman-Robertson Proj. Rep. W-17-3, W-17-4, and W-17-5 [*cited in* Angliss and Lodge 2004].

Burns, J.J. 1981. *Bearded Seal Erignathus barbatus Erxleben, 1777*. p. 145-170 In S.H. Ridgway and R.J. Harrison (eds.), Handbook of Marine Mammals. Vol. 2. Seals. Academic Press, New York.

Calambokidis, J., J.D. Darling, V. Deeke, P. Gearin, M. Gosho, W. Megill, C.M. Tombach, D. Goley, C. Toropova and B. Gisbourne. 2002. *Abundance, Range and Movements of a Feeding Aggregation of Gray Whales (Eschrichtius robustus) from California and Southeastern Alaska in 1998*. J. Cet. Res. Manage. 4(3):267- 276.

Clarke, J.T., S.E. Moore and D.K. Ljungblad. 1989. *Observations on Gray Whale (Eschrichtius robustus) Utilization Patterns in the Northeastern Chukchi Sea, July-October 1982-1987.* Can. J. Zool. 67(11):2646-2654.

Clarke, J.T., S.E. Moore and M.M. Johnson. 1993. *Observations on Beluga Fall Migration in the Alaskan Beaufort Sea, 198287, and Northeastern Chukchi Sea, 198291.* Rep. International Whaling Commission 43:387-396.

Darling, J.D. 1984. *Gray Whales off Vancouver Island, British Columbia.* Pp. 267-287, In M.L. Jones, S.L. Swartz, and S. Leatherwood (eds.), The Gray Whale, Eschrichtius robustus. Academic Press, Inc., Orlando. xxiv + 600 pp.

Davis, R.A. and C.R. Evans. 1982. *Offshore Distribution and Numbers of White Whales in the Eastern Beaufort Sea and Amundsen Gulf, Summer 1981.* Rep. from LGL Ltd., Toronto, Ont., for Sohio Alaska Petrol. Co., Anchorage, AK, and Dome Petrol. Ltd., Calgary, Alb. (co-managers). 76 p.

DeMaster, D.P., W. Perryman, and L.F. Lowry. 1998. *Beluga Whale Surveys in the Eastern Chukchi Sea, July, 1998.* Alaska Beluga Whale Committee Rep. 98-2. 16 pp.

Frost, K.J. and L.F. Lowry. 1981. *Foods and Trophic Relationships of Cetaceans in the Bering Sea.* p. 825-836 In: D.W. Hood and J.A. Calder (eds.) The Eastern Bering Sea Shelf: Oceanography and Resources, Vol. 2. Univ. Wash. Press, Seattle.

Frost, K.J., L.F. Lowry, J.R. Gilbert, and J.J. Burns. 1988. *Ringed Seal Monitoring: Relationships of Distribution and Abundance to Habitat Attributes and Industrial Activities.* Final Rep. contract no. 84-ABC-00210 submitted to U.S. Department of Interior, Minerals Management Service, Anchorage, AK. 101 pp.

Frost, K.J., L.F. Lowry, and G. Carroll. 1993. *Beluga Whale and Spotted Seal Use of a Coastal Lagoon System in the Northeastern Chukchi Sea.* Arctic 46:8-16.

Frost, K.J. and L.F. Lowry. 1999. *Monitoring Distribution and Abundance of Ringed Seals in Northern Alaska*. Interim Rep. Cooperative Agreement Number 14-35-0001-30810 submitted to the U.S. Department of Interior, Minerals Management Service, Anchorage, AK. 37p + appendix.

Frost, K.J., L.F. Lowry, G. Pendleton, and H.R. Nute. 2002. *Monitoring Distribution and Abundance of Ringed Seals in Northern Alaska.* OCS Study MMS 2002-04. Final Report from the Alaska Department of Fish and Game, Juneau, AK, for U.S. Minerals Management Service, Anchorage, AK. 66 pp. + Appendices.

George, J.C., J. Zeh, R. Suydam, and C. Clark. 2004. *Abundance and Population Trend (1978-2001) of Western Arctic Bowhead Whales Surveyed Near Barrow, Alaska.* Marine Mammal Science. 20(4):755-773.

Gulland, F.M.D., H. Pérez-Cortés M., J. Urgán R., L. Rojas-Bracho, G. Ylitalo, J. Weir, S.A. Norman, M.M. Muto, D.J. Rugh, C. Kreuder, and T. Rowles. 2005. *Eastern North Pacific Gray Whale (Eschrichtius robustus) Unusual Mortality Event, 1999-2000.* U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-150, 33 pp.

Hall, J.D., M.L. Gallagher, K.D. Brewer, P.R. Regos, P.E. Isert. 1994. *1993 Kuvlum Exploration Area Site Specific Monitoring Program.* Coastal & Offshore Pacific Corporation, for Arco Alaska, Inc. 219 p.

Hammill, M.O., C. Lydersen, M. Ryg and T.G. Smith. 1991. *Lactation in the Ringed Seal (Phoca hispida).* Can. J. Fish. Aquatic Sci. 48(12):2471-2476.

Harwood, L.A. and I. Stirling. 1992. *Distribution of Ringed Seals in the Southeastern Beaufort Sea During Late Summer.* Can. J. Zool. 70(5):891-900.

Harwood, L.A., S. Innes, P. Norton, and M.C.S. Kingsley. 1996. *Distribution and Abundance of Beluga Whales in the Mackenzie Estuary, Southeast Beaufort Sea and West Amundsen Gulf During Late July 1992.* Can. J. Fish. Aquat. Sci. 53:2262-2273.

Hazard, K. 1988. Beluga whale, Delphinapterus leucas. Pp. 195-235. In: *J. W. Lentfer (ed.), Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations*. Marine Mammal Commission, Washington, D.C.

IWC 1992. *Report of the Scientific Committee*. Report of the International Whaling Commission 42:51-270.

Johnson, S.R. 1979. *Fall Observations of Westward Migrating White Whales (Delphinapterus leucas) Along the Central Alaskan Beaufort Sea Coast.* Arctic 32(3): 275-276.

Johnson, C.B., B.E. Lawhead, J.R. Rose, M.D. Smith, A.A. Stickney, A.M. Wildman. 1999. *Wildlife Studies on the Colville River Delta, Alaska, 1998.* Rep. from ABR, Inc., Fairbanks, AK, for ARCO Alaska, Inc., Anchorage, AK.

Kelly, B.P. 1988. Bearded seal, Erignathus barbatus. p. 77-94 In: J.W. Lentfer (ed.), *Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations.* Marine Mammal Commission, Washington, DC. 275 p.

Kelly, B.P., Harding, O.P., Kunnasranta,M., Quakenbush, L.T., Taras, B.D. 2005. *Correction Factor for Ringed Seal Surveys in Northern Alaska*. OCS Study MMS 2005-006. U.S. Minerals Manage. Serv., Anchorage, AK. 37 p.

Kingsley, M.C.S. 1986. *Distribution and Abundance of Seals in the Beaufort Sea, Amundsen Gulf, and Prince Albert Sound, 1984.* Environ. Studies Revolving Funds Rep. No. 25. 16 p.

LGL Alaska Res. Assoc. Inc. 2005. *Request by the University of Alaska to Allow the Incidental Take of Marine Mammals During a Marine Geophysical Survey across the Arctic Ocean*. Submitted by University of Alaska to U.S. Department of Commerce/National Oceanic & Atmospheric Administration/National Marine Fisheries Service LGL Report TA4122-2, 132 p. Available at http://www.nmfs.noaa.gov/pr/pdfs/permits/healy_iha_app.pdf

LGL and Greeneridge. 1996. *Northstar Marine Mammal Monitoring Program, 1995: Baseline Surveys and Retrospective Analyses of Marine Mammal and Ambient Noise Data from the Central Alaskan Beaufort Sea.* Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Exploration (Alaska) Inc., Anchorage, AK. 104 p.

LGL Limited and Greeneridge Sciences, Inc. 1987. *Responses of bowhead whales to an offshore drilling operation in the Alaskan Beaufort Sea, Autumn 1986.* Shell Western E&P Inc.

Ljungblad, D.K., S.E. Moore, J.T. Clarke and J.C. Bennett. 1987. *Distribution, abundance, behavior and bioacoustics of endangered whales in the Alaskan Beaufort and eastern Chukchi Seas.* 1979-86. OCS Study MMS 87-0039.

Ljungblad, D.K., S.E. Moore and D.R. Van Schoik. 1984. *Aerial Surveys of Endangered Whales in the Beaufort, Eastern Chukchi, and Northern Bering Seas, 1983: with a Five Year Review, 1979-1983.* NOSC Tech Rep. 955. Rep. from Naval Ocean Systems Center, San Diego, CA for U.S. Minerals Management Service, Anchorage, AK. 356 p. NTIS AD-A146 373/6.

Lowry, L.F., K.J. Frost, R. Davis, R.S. Suydam, and D.P. DeMaster. 1994. *Movements and Behavior of Satellite-tagged Spotted Seals (Phoca largha) in the Bering and Chukchi Seas.* U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-38. 71 pp.

Lowry, L.F., K.J. Frost, R. Davis, D.P. DeMaster and R.S. Suydam. 1998. *Movements and Behavior of Satellitetagged Spotted Seals (Phoca largha) in the Bering and Chukchi Seas.* Polar Biol. 19(4):221-230.

Lowry, L. and K. Frost. 2002. *Beluga Whale Surveys in the Eastern Chukchi Sea, July 2002.* Alaska Beluga Whale Committee Rep. 02-2 submitted to NMFS, Juneau, AK. 10p. [*cited in* Angliss and Outlaw 2005].

Lydersen, C. and M.O. Hammill. 1993. *Diving in Ringed Seal (Phoca hispida) Pups During the Nursing Period.* Can. J. Zool. 71(5):991-996.

Maher, W.J. 1960. *Recent Records of the California Gray Whale (Eschrichtius glaucus) Along the North Coast of Alaska.* Arctic 13(4):257-265.

Miller, G.W., R.E. Elliott and W.J. Richardson. 1998. Whales. p. 5-1 to 5-109 In: W.J. Richardson (ed.), *Marine Mammal and Acoustical Monitoring of Western Geophysical's Open-water Seismic Program in the Alaskan Beaufort Sea, 1998.* LGL Rep. TA2230-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and U.S. National Marine Fisheries Service, Anchorage, AK, and Silver Spring, MD. 390 p.

Miller, G.W., R.E. Elliot, W.R. Koski, V.D. Moulton, and W.J. Richardson. 1999. Whales. In W.J. Richardson (ed.). *Marine Mammal and Acoustical Monitoring of Western Geophysical's Open-Water Seismic Program in the Alaskan Beaufort Sea, 1998.*

Miller, G.W., R.E. Elliott, T.A. Thomas, V.D. Moulton, and W.R. Koski. 2002. *Distribution and Numbers of Bowhead Whales in the Eastern Alaskan Beaufort Sea During Late Summer and Autumn, 1979-2000 in Richardson, W.J. and D.H. Thomson (eds.). 2002.* Bowhead Whale Feeding in the Eastern Alaskan Beaufort Sea: Update of Scientific and Traditional Information. OCS Study MMS 2002-012; LGL Rep. TA2196-7. Rep. from LGL Ltd., King City, Ont., for U.S. Minerals Management Service, Anchorage, AK, and Herndon, VA. Vol. 1, xliv + 420 p; Vol. 2, 277 p.

Moore, S.E. and R.R. Reeves. 1993. *Distribution and Movement*. Pp. 313-386, In J.J. Burns, J.J. Montague, and C J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammalogy, Spec. Publ. No. 2.

Moore, S.E. 2000. *Variability in Cetacean Distribution and Habitat Section in the Alaskan Arctic, Autumn 1982-91*. Arctic. 53(4):448-460.

Moore, S.E., D.P. DeMaster and P.K. Dayton. 2000b. *Cetacean Habitat Selection in the Alaskan Arctic During Summer and Autumn*. Arctic 53(4):432-447.

Moore, S.E., J.M. Waite, L.L. Mazzuca and R.C. Hobbs. 2000c. *Mysticete Whale Abundance and Observations of Prey Associations on the Central Bering Sea Shelf*. J. Cetac. Res. Manage. 2(3): 227-234.

Moore, S.E., J.M. Grebmeier and J.R. Davies. 2003. *Gray Whale Distribution Relative to Forage Habitat in the Northern Bering Sea: Current Conditions and Retrospective Summary*. Can. J. Zool. 81(4):734-742.

Moulton, V.D. and J.W. Lawson. 2002. Seals, 2001. p. 3-1 to 3-48 *In*: *W.J. Richardson (ed.), Marine Mammal and Acoustical Monitoring of WesternGeco's Open Water Seismic Program in the Alaskan Beaufort Sea, 2001*. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for WesternGeco, Houston, TX, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. LGL Rep. TA2564-4.

Moulton, F.D., W.J. Richardson, T.L. McDonald, R.E. Elliott, and M.T. Williams. 2002. *Factors Influencing Local Abundance and Haulout Behavior of Ringed Seals (Phoca hispida) on Landfast ice of the Alaskan Beaufort Sea.* Can. J. Zool. 80:1900-1917.

Moulton, V.D., W.J. Richardson, M.T. Williams and S.B. Blackwell. 2003a. *Ringed Seal Densities and Noise Near an Icebound Artificial Island with Construction and Drilling.* Acoust. Res. Let. Online. 4(4):112–117.

Moulton, V.D., W.J. Richardson, T.L. McDonald, R.E. Elliott, M.T. Williams and C. Nations. 2003b. *Effects of Northstar on Local Abundance and Distribution of Ringed Seals (Phoca hispida) of the Alaskan Beaufort Sea.* p. 5–1 to 5–24 In: W.J. Richardson and M.T. Williams (eds., 2003, q.v.). LGL Rep. TA2702-4.

Moulton, V.D., R.E. Elliott and M.T. Williams. 2003c. *Fixed-wing Aerial Surveys of Seals Near BP's Northstar and Liberty Sites, 2002*. p. 4-1 to 4-35 In: W.J. Richardson and M.T. Williams (eds., 2003, q.v.). LGL Rep. TA2702-2.

O'Corry-Crowe, G.M., R.S. Suydam, A. Rosenberg, K.J. Frost, and A.E. Dizon. 1997. *Phylogeography, Population Structure and Dispersal Patterns of the Beluga Whale Delphinapteras leucas in the Western Nearctic Revealed by Mitochondrial DNA.* Mol. Ecol. 6:955-970.

Quakenbush, L.T. 1988. Spotted seal, Phoca largha. p. 107-124 In: J.W. Lentfer (ed.), *Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations.* Marine Mammal Commission, Washington, DC. 275 p.

Quan, J. 2000. *Summer Resident Gray Whales of Washington State: Policy, Biological and Management Implications of Makah Whaling.* MS. Thesis. School of Marine Affairs, University of Washington. Seattle, WA.

Rice, D.W. and A.A. Wolman. 1971. *The Life History and Ecology of the Gray Whale (Eschrichtius robustus*). Am. Soc. Mamm. Spec. Publ. 3. 142 p.

Rice, D.W., A.A. Wolman, D.E. Withrow, and L.A. Fleischer. 1981. *Gray Whales on the Winter Grounds in Baja California*. Rep. International Whaling Commission 31:477-493.

Rice, D.W. 1998. *Marine Mammals of the World, Systematics and Distribution.* Spec. Publ. 4. Soc. Mar. Mammal., Allen Press, Lawrence, KS. 231 p.

Richard, P.R., A.R. Martin and J.R. Orr. 1997. *Study of Summer and Fall Movements and Dive Behaviour of Beaufort Sea Belugas, Using Satellite Telemetry: 1992-1995*. ESRF Rep. 134. Environ. Stud. Res. Funds, Calgary, Alb. 38 p.

Richard, P.R., A.R. Martin and J.R. Orr. 2001. *Summer and Autumn Movements of Belugas of the Eastern Beaufort Sea Stock*. Arctic 54(3):223-236.

Richardson, W. John and Denis H. Thomson, eds. LGL Limited, Environmental Research Associates and LGL Ecological Research Associates, Inc.; for the Department of the Interior, Minerals Management Service, Alaska Outer Continental Shelf Region. *Bowhead Whale Feeding in the Eastern Alaskan Beaufort Sea: Update of Scientific and Traditional Information*. Anchorage, AK: Minerals Management Service, Alaska OCS Region, [2002].

Richardson, W.J., C.R. Greene, Jr., C.I. Malme and D.H. Thomson. 1995. *Marine Mammals and Noise*. Academic Press, San Diego. 576 p.

Richardson, W.J., G.W. Miller, and C.R. Greene Jr. 1999. *Displacement of Migrating Bowhead Whales by Sounds from Seismic Surveys in Shallow Waters of the Beaufort Sea*. *Journal of the Acoustical Society of America* 106: 2281.

Rugh, D.J. and M.A. Fraker. 1981. *Gray Whale (Eschrichtius robustus) Sightings in Eastern Beaufort Sea*. Arctic 34(2):186-187.

Rugh, D.J., K.E.W. Shelden and D.E. Withrow. 1997. *Spotted Seals, Phoca largha, in Alaska*. Mar. Fish. Rev. 59(1):1-18.

Rugh, D., D. DeMaster, A. Rooney, J. Breiwick, K. Shelden, and S. Moore. 2003. *A Review of Bowhead Whale (Balaena mysticetus) Stock Identity.* Journal of Cetacean Research and Management 5(3): 267-279.

Rugh, D.J., R.C. Hobbs, J.A. Lerczak and J.M. Breiwick. In press. *Estimates of Abundance of the Eastern North Pacific Stock of Gray Whales 1997-2002.* J. Cetacean Res. Manage.

Shaughnessy, P.D. and F.H. Fay. 1977. *A Review of the Taxonomy and Nomenclature of North Pacific Harbor Seals.* J. Zool. (Lond.) 182:385-419.

Simpkins, M.A., L.M. Hiruki-Raring, G. Sheffield, J.M. Grebmeier, and J.L. Bengtson. 2003. *Habitat Selection by Ice-associated Pinnipeds Near St. Lawrence Island, Alaska in March 2001*. Polar Biol. 26:577-586.

Smith, T.G. 1973. *Population Dynamics of the Ringed Seal in the Canadian Eastern Arctic*. Fish. Res. Board Can. Bull. 181. 55 p.

Smith, T.G. and I. Stirling. 1975. The Breeding Habitat of the Ringed Seal (Phoca hispida). *The Birth Lair and Associated Structures.* Can. J. Zool. 53(9):1297-1305.

Smith, T.G., and M.O. Hammill. 1981. *Ecology of the Ringed Seal, Phoca hispida, in its Fast-ice Breeding Habitat.* Can. J. Zool. 59:966-981.

Smith, T.G. 1987. *The Ringed Seal, Phoca hispida, of the Canadian Western Arctic.* Can. Bull. Fish. Aquat. Sci. 216: 81 p.

Suydam, R.S., R.P. Angliss, J.C. George, S.R. Braund and D.P. DeMaster. 1995. *Revised Data on the Subsistence Harvest of Bowhead Whales (Balaena mysticetus) by Alaska Eskimos, 1973-1993.* Rep. International Whaling Commission 45:335-338.

Stirling, I., M. Kingsley and W. Calvert. 1982. *The Distribution and Abundance of Seals in the Eastern Beaufort Sea, 1974-79*. Occasional Paper No. 47, Canadian Wildlife Service, Edmonton, Alberta.

Suydam, R.S., L.F. Lowry, K.J. Frost, G.M. O'Corry-Crowe and D. Pikok Jr. 2001. *Satellite Tracking of Eastern Chukchi Sea Beluga Whales into the Arctic Ocean*. Arctic 54(3):237-243.

Suydam, R.S. and George, J.C. 2004. *Subsistence Harvest of Bowhead Whales (Balaena mysticetus) by Alaskan Eskimos, 1974 to 2003.* Unpublished report submitted to International Whaling Commission (SC/56/BRG12). 12pp.

Treacy, S.D. 2000. *Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 1998-1999*. OCS Study MMS 2000-066. U.S. Minerals Management Service, Anchorage, AK. 135 p.

Treacy, S.D. 2002a. *Aerial surveys of Endangered Whales in the Beaufort Sea, Fall 2000*. OCS Study MMS 2002-014. U.S. Minerals Management Service, Anchorage, AK. 111 p.

Treacy, S.D. 2002b. *Aerial surveys of Endangered Whales in the Beaufort Sea, Fall 2001*. OCS Study MMS 2002-061. U.S. Minerals Management Service, Anchorage, AK. 117 p.

USDI/BLM (U.S. Department of the Interior/Bureau of Land Management). 2005. *Northwest National Petroleum Reserve – Alaska; Final Amended Integrated Activity Plan/Environmental Impact Statement.*

Williams, M.T. and J.A. Coltrane (eds.). 2002. *Marine Mammal and Acoustical Monitoring of the Alaska Gas Producers Pipeline Team's Open Water Pipeline Route Survey and Shallow Hazards Program in the Alaskan Beaufort Sea, 2001*. LGL Rep. P643. Rep. from LGL Alaska Res. Assoc. Inc., Anchorage, AK, for BP Exploration (Alaska) Inc., ExxonMobil Production, Phillips Alaska Inc., and National Marine Fisheries Service 103 p.

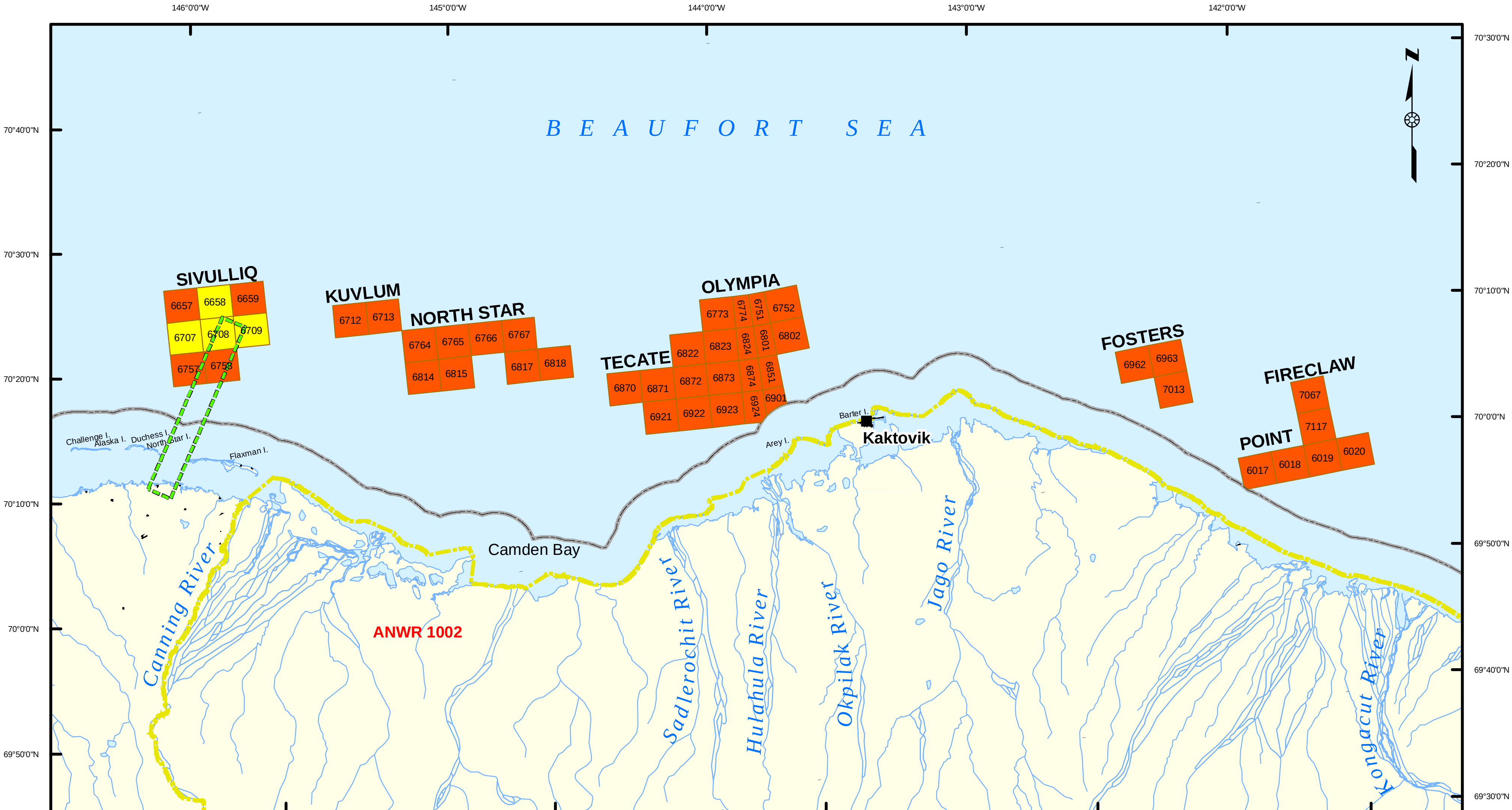
Williams, M.T., R. Rodrigues, V.D. Moulton and S.B. Blackwell. 2004. *Summary of Ringed Seal Responses During the Break-up and Open Water Period*. p. 6-1 to 6-8 In: W.J. Richardson and M.T. Williams (eds., 2004, q.v.). LGL Rep. TA 4002-6

Woodby, D.A. and D.B. Botkin. 1993. *Stock Sizes Prior to Commercial Whaling.* p. 387-407 In: J.J. Burns, J.J. Montague and C.J. Cowles (eds.), The Bowhead Whale. Spec. Publ. 2. Soc. Mar. Mamm., Lawrence, KS. 787 p.

Zeh, J.E. and Punt, A.E. 2005. *Updated 1978-2001 abundance estimates and their correlations for the Bering-Chukchi-Beaufort Seas stock of bowhead whales.* J. Cetacean Res. Manage. 7(2):169-175.

Zeh, J.E., C.W. Clark, J.C. George, D. Withrow, G.M. Carroll and W.R. Koski. 1993. *Current Population Size and Dynamics*. p. 409-489 In: J.J. Burns, J.J. Montague and C.J. Cowles (eds.), The Bowhead Whale. Spec. Publ. 2. Soc. Mar. Mammal., Lawrence, KS. 787 p.

Zeh, J.E., A.E. Raftery, and A.A. Schaffner. 1996. Revised Estimates of Bowhead Population Size and Rate of Increase. Rep. International Whaling Commission 46:670.



Key:

- Shell Lease Blocks where drilling is proposed during 2007
- Shell Lease Blocks
- Prospective Pipeline Access Corridor where Geotech Boreholes are proposed for drilling during 2007
- State-Federal Water Boundary
- Arctic National Wildlife Refuge
- Villages
- Roads

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory & Technical Services

SHELL OFFSHORE INC.

Lease Blocks and Prospective
Pipeline Access Corridor
Proposed for Drilling during 2007

SCALE: 0 5 10 20 Mi

FIGURE: 1

Lynx: 15067-188.mxd, 10/09/06, R00

Attachment A Equipment Specifications

Attachment A

Offshore Alaska
Beaufort Sea

Open Water Drilling

Equipment Specifications

December 2006

Table of Contents

APPENDIX 1 – DRILLING UNIT SPECIFICATIONS
CDU Kulluk

CDU Kulluk

Kulluk

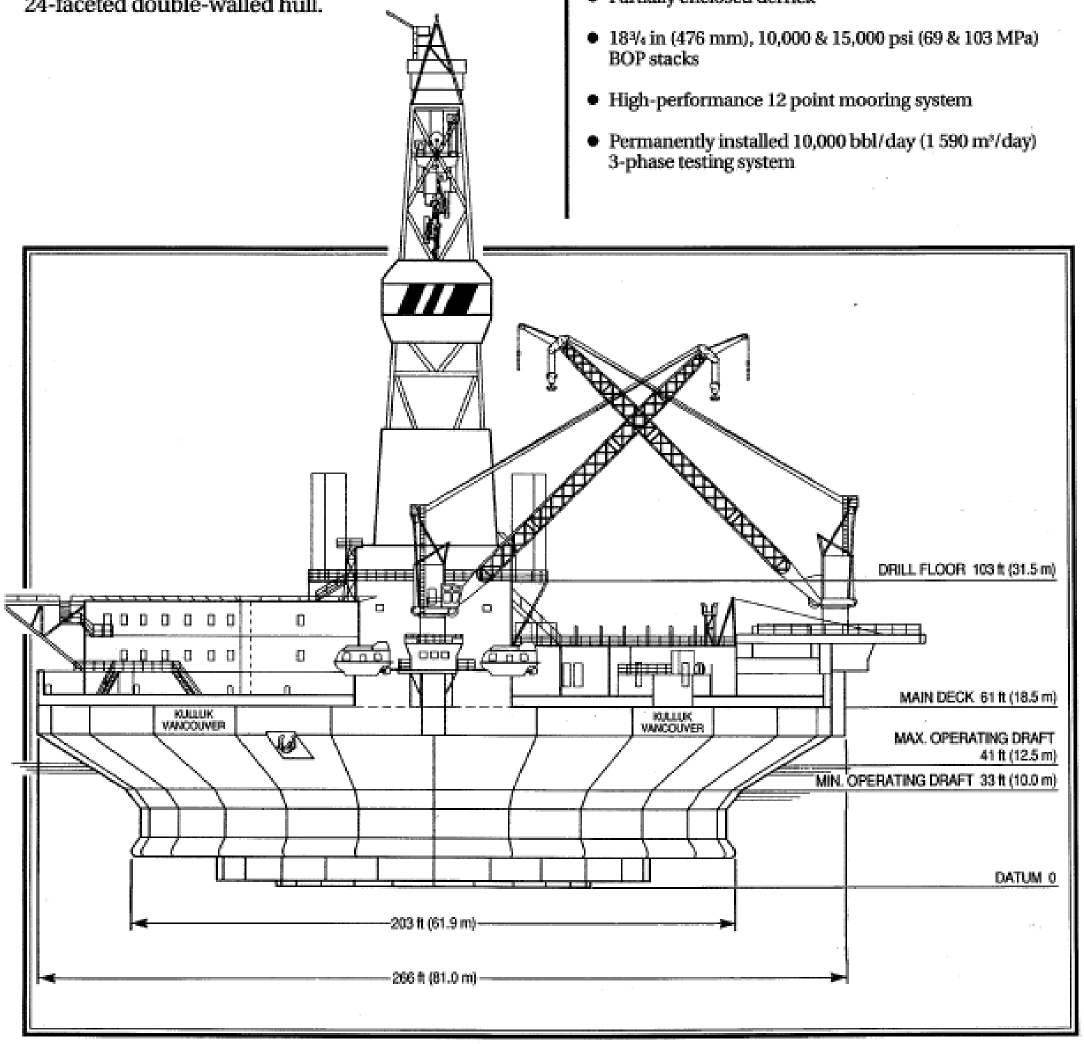
BeauDril

Kulluk is the first floating drilling vessel designed and constructed for extended season drilling operations in deep Arctic waters.

An improvement on the floating drillship concept, Kulluk is a conically shaped, ice strengthened floating drilling unit with a 24-faceted double-walled hull.

Key Features

- Unique, purpose-built conical Arctic Class IV hull design
- Operating water depth 60 to 600 ft (18.3 to 183 m), drilling depth up to 20,000 ft (6 096 m)
- Electrically driven Varco top drive drilling system
- 24 ft (7.3 m) diameter glory hole bit capable of drilling and setting a steel caisson 40 ft (12.2 m) into the seabed for ice scour protection
- Partially enclosed derrick
- 18¾ in (476 mm), 10,000 & 15,000 psi (69 & 103 MPa) BOP stacks
- High-performance 12 point mooring system
- Permanently installed 10,000 bbl/day (1 590 m^3/day) 3-phase testing system



Weight 17,000 tons

Classification

The unit has been designated as Arctic Class IV (by the Canadian Coast Guard) under Canadian Arctic Shipping Pollution Prevention Regulations, and as Ice Class 1AA by the American Bureau of Shipping.

Specifications

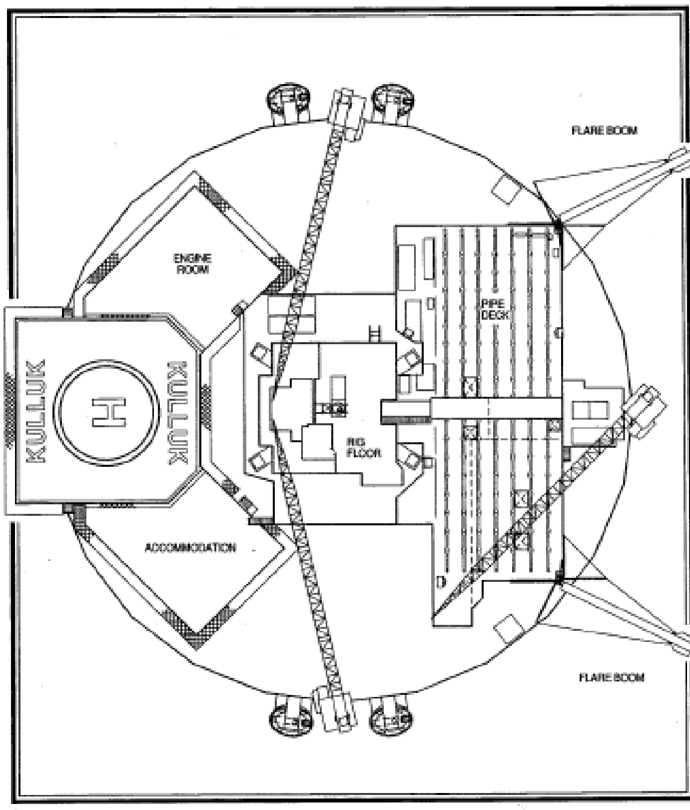
Owner:	BeauDril Limited
Flag:	Canadian
Rig Type:	Conical Drilling Unit (CDU)
Delivered:	1983
Rig Design:	Earl & Wright - Lavalin
Built By:	Mitsui Engineering and Shipbuilding, Japan

Dimensions

Diameter at main deck:	266 ft (81.0 m)
Diameter at pump deck:	196 ft (59.7 m)
Hull Depth:	61 ft (18.5 m)

Operations

Draft (max. operating):	41 ft (12.5 m)
Draft (min. operating):	33 ft (10.0 m)
Draft (light ship):	26 ft (8.0 m)
Light Ship Displacement:	19,300 tons (17 510 tonnes)
Maximum Drilling Depth:	20,000 ft (6 096 m)
Operating Water Depth:	60 to 600 ft (18.3 to 183 m)



Variable Load

7,717 tons (7 000 tonnes)

Storage Capacities

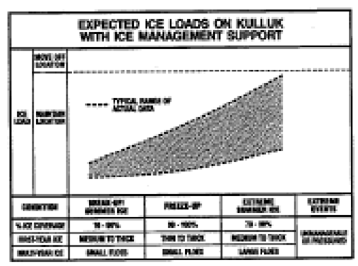
Barite & cement bulk:	21,471 cf (608 m³)
Liquid mud:	2,605 bbl (414 m³)
Drill water:	4,227 bbl (672 m³)
Fuel:	10,085 bbl (1 603 m³)
Potable water:	1,961 bbl (312 m³)
Ballast:	35,928 bbl (5 712 m³)
Pipe & casing (pipe deck):	1,543 tons (1 400 tonnes)
Brine:	2,010 bbl (320 m³)

Operational Limits

Stationkeeping Conditions

Kulluk was built to operate in the ice infested waters of the Arctic offshore. The unit was developed to extend the drilling season available to more conventional floating vessels by enabling operations to be carried out through spring breakup conditions, the summer months, and well into the early winter period.

Kulluk was designed to maintain location in a drilling mode in moving first-year ice of 4 ft (1.2 m) thickness. With ice management support provided by BeauDril's Arctic Class IV icebreakers, the unit can maintain location in more severe conditions as shown below.



In terms of Kulluk's open water performance, the drilling unit was designed to maintain location in storm conditions associated with maximum wave heights of 18 ft (5.5 m) while drilling and 40 ft (12.2 m) while disconnected (assumed storm duration of 24 hrs).

If ice or open water storm conditions become more severe than those indicated, the unit's mooring system, which incorporates acoustic release devices, is disconnected from the anchors and the unit moves off location.

Equipment

Drilling Equipment

Derrick
160 ft (44.8 m) Dreco dynamic with a 40 ft x 40 ft (12.2 m x 12.2 m) base, rated at 1,400,000 lb (623 000 daN) with 14 lines

Racking platform has capacity to hold 23,340 ft (7 115 m) of 5 in (127 mm) drill pipe plus bottom hole assembly

Drawworks
Ideco E-3000 electric drawworks complete with sand reel, Elmago model 7838 Baylor auxiliary brake, spinning and breakout catheads and three GE model 752 motors each rated at 1,000 hp (746 kW) continuous

Travelling Block
McKissick model 686, 650 ton (590 tonne) capacity with 7 sheaves grooved for 1⅝ in (41.3 mm) drilling line

Swivel
Ideco TL-500, 500 ton (454 tonne) capacity

Drill Pipe
20,000 ft (6 096 m) x 5 in (127 mm), 19.5 lb/ft (29 kg/m) with 4½ IF connections

Top Drive
Varco TDS-3 with one GE model 752 motor rated at 1,000 hp (746 kW) continuous and a 500 ton (454 tonne) hoisting capacity

Rotary Table
Ideco LR-495, 49.5 in (1 257 mm) driven by one GE model 752 motor, rated at 1,000 hp (746 kW) continuous, coupled to a two speed transmission

Drill String Compensator
NL Shaffer 18 ft (5.5 m) stroke 400,000 lb (178 000 daN) compensating capacity or a 1,000,000 lb (444 800 daN) locked capacity

Tensioner System
4 x 80,000 lb (35 600 daN) Western Gear riser tensioners, 48 ft (14.6 m) wireline travel with 1¾ in (44.5 mm) wire rope

6 x 16,000 lb (7 100 daN) Western Gear guideline/pod tensioners, 40 ft (12.2 m) wireline travel with ¾ in (19.1 mm) wire rope

Mud Pumps
2 x Ideco T1600 triplex, each driven by two GE model 752 motors rated at

Cementing Unit
Dowell owned R717 twin triplex powered by two GE model 752 motors each rated at 1,000 hp (746 kW) continuous, with 7,500 psi (52 MPa) and 10,500 psi (72 MPa) fluid ends

Rig Floor Pipe Handling System
Varco Iron Roughneck model IR-2000 Range: 2⅞ to 8 in (73 to 203 mm)

Mud Logging Room

Designed to accommodate equipment from any of the major mud logging companies. This room is an integral part of the rig and contains complete lab facilities

Testing Equipment

Complete testing system with a 10,000 BOPD (1 590 m³/day) capacity consisting of: data header, choke manifold, steam heater, 3-phase separator, surge tank, water degasser, transfer pumps, and flare booms

Mud Conditioning Equipment

4 x Thule United VSM-120 shale shakers
1 x Brandt SR-3 desander
1 x Brandt SE-24 desilter
1 x Thule VSM-200 mud cleaner
1 x Wagner Sigma-100 centrifuge
1 x Sharples DM 40 000 centrifuge
2 x Burgess Magna-Vac vacuum degassers
2 x Alfa-Laval AX30 mud coolers

Subsea Equipment

BOP System
1 x NL Shaffer 18¾ in (476 mm), 10,000 psi (69 MPa) BOP stack with annular, 4 ram type preventors, and Vetco H-4 E connector

1 x NL Shaffer 18¾ in (476 mm), 15,000 psi (103 MPa) BOP stack with annular rated at 10,000 psi (69 MPa), 4 ram type preventors, and Vetco H-4 E x F connector

Lower Marine Riser Packages
2 x 18¾ in (476 mm) with 10,000 psi (69 MPa) Shaffer annular, Regan 24 in (610 mm) CR-1 pressure compensated lower ball joint and Vetco H-4E connector

BOP Cranes
2 x Hepburn main bridge cranes, 85 ton (77 tonne) capacity each with 10 ton (9.1 tonne) auxiliary hoists

30 in (762 mm) Marine Riser System
3 x hydraulic pin connectors; 2 x 36 in (914 mm) Cameron and 1 x 30 in (762 mm) Dril-Quip

1 x Regan 28 in (711 mm) CR-1 pressure compensated lower ball joint

30 in (762 mm) riser consisting of 1 in (25.4 mm) wall casing with Hunting Lynx 52S connectors

1 x Regan 28 in (711 mm) telescoping riser joint with 45 ft (13.7 m) stroke

1 x Regan 28 in (711 mm) DR-1 upper ball joint

1 x Regan KFDS 28 in (711 mm) diverter

21¼ in (540 mm) Marine Riser System
21¼ in (540 mm) Cameron RCK riser with 10,000 psi (69 MPa) choke and kill lines

2 x Cameron telescoping riser joints, 1 x 40 ft (12.2 m), and 1 x 50 ft (15.2 m) stroke

1 x Regan 24 in (610 mm) DR-1 upper ball joint

1 x Regan KFDS 24 in (610 mm) diverter

Glory Hole Bit
1 x Brown Tornado, 24 ft (7.3 m) diameter hydraulically operated with airlift discharge. Capable of drilling a glory hole 40 ft (12.2 m) into the seabed for ice scour protection

Power Generation

Prime Movers:
3 x Electro-Motive Diesel rated at 2,817 hp (2 100 kW) each

Emergency Power:
1 x GM Detroit diesel rated 873 hp (651 kW)

Cranes

3 x Liebherr, BOS 65/850, rated at 72 ton (65 tonne) at 30 ft (9.1 m)

Safety Equipment

4 x Whittaker 54-person survival craft; two on port, two on starboard

1 x Hurricane Model 700-D emergency rescue boat

2 x RFD inflatable escape slides

Helideck

Capacity for Sikorsky 61 or similar with fueling station

Accommodation

Bunks for 108 people, recreation room, sauna, galley with seating for 36, offices, and hospital

Kulluk Mooring System

The Kulluk's mooring system consists of twelve Hepburn winches located on the outboard side of the main deck. Anchor wires lead off the bottom of each winch drum inboard for approximately 55 ft (17 m). The wire is then redirected by a sheave, down through a hawse pipe to an underwater, ice protected, swivel fairlead. The wire travels from the fairlead directly under the hull to the anchor system on the seafloor.

Specifications

Anchor Winch
12 x Hepburn single-drum winches with a 287 ton (260 tonne) operating tension

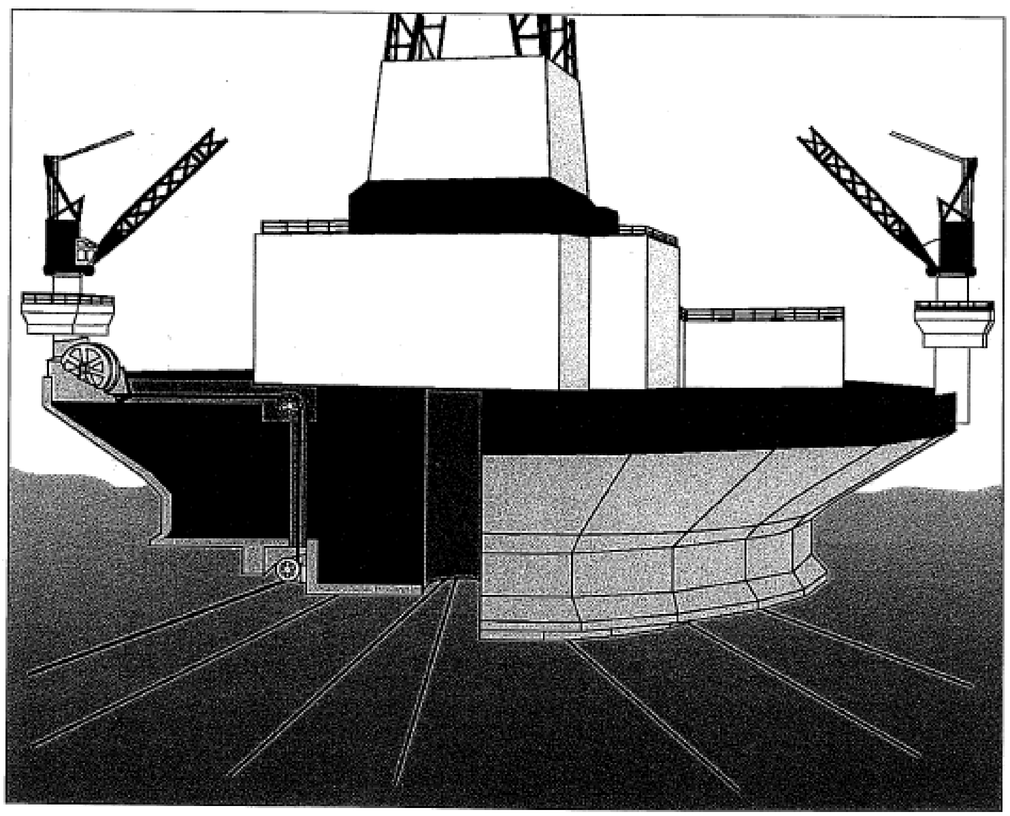
Mooring Wires and Anchors

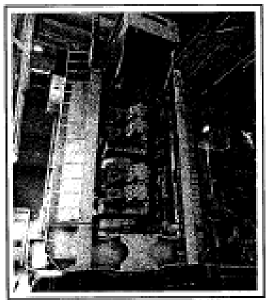
Anchors:
Various sizes & quantities of anchors are available for use. Exact anchor configuration to be provided once location and seafloor conditions are specified

Wire ropes:
Each winch drum has capacity for 3,763 ft (1 147 m) of $3^1/_2$ in (88.9 mm), 573 ton (520 tonne) breaking strength wireline

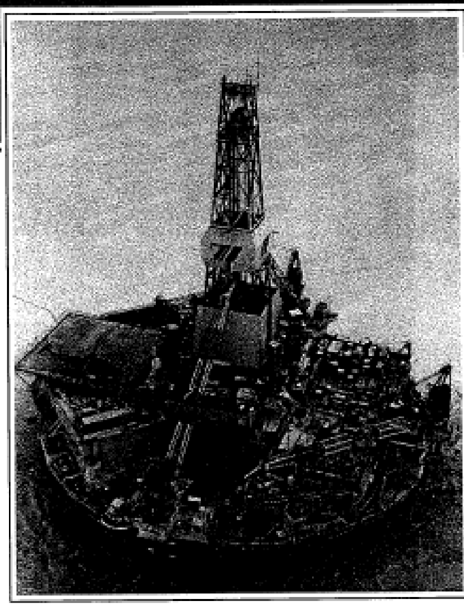
Anchor Release:
Each anchor wire contains a remote acoustic release (RAR) unit

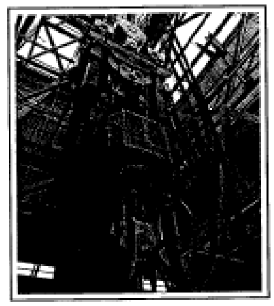
FOR MORE INFORMATION ABOUT KULLUK, CONTACT MANAGER, BEAUDRIL AT (403) 233-3030.



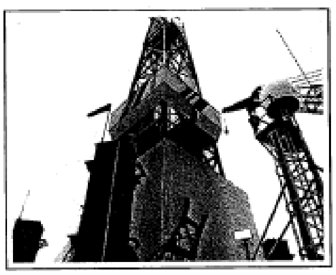


Two complete BOP systems

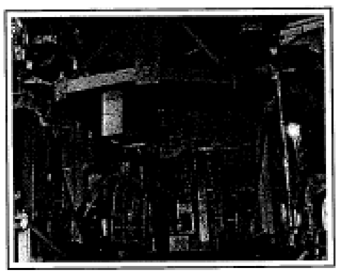




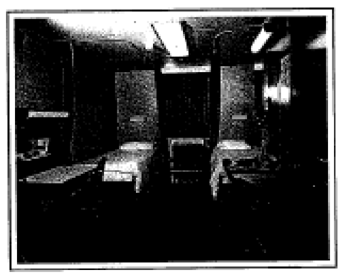
Varco TDS-3 top drive drilling system



Derrick enclosed to A-frame for harsh Arctic environment

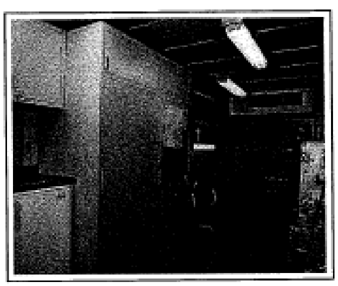


24 ft (7.3 m) diameter glory hole bit

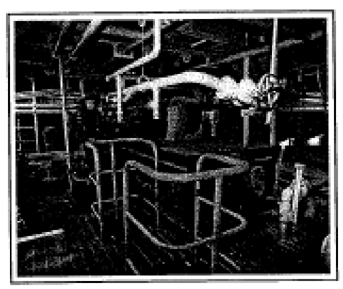


Typical two man room in 108 man accommodation

Inside storage for drilling and rental tools



Pressurized mud logging room



Dual purpose barite recovery/solids control centrifuge

APPENDIX 2 – DRILLING VESSEL SPECIFICATIONS
Discoverer Drilling Vessel

Drill Ship Frontier Discoverer

1 RIG GENERAL

10 SUMMARY SPECIFICATION

100 SPECIFICATIONS

Unit Specification

Name	Frontier Discoverer
Type - design	Drillship – Sonat Offshore Drilling Discoverer Class
Shape	Monohull
Flag	Panama (will be changed to Marshall Islands)
Official number	14334-B4-D
IMO number	6608608
Signal letters	TBA
Unit classifications	ABS Maltese Cross, 1 A1 Drilling Unit (changing to DNV)
Class ID number	27355
Ship builders	Namura Zonshno Shipyard, Osaka, Japan – hull number 355
Year of Hull Construction	1965
Converting yard	Avondale Shipyards, New Orleans, Louisiana, USA
Year of conversion	1976
Date of last dry-docking	In process

Principle dimensions

LOA	156.7 m	514 ft
LBP	148.2 m	486 ft
Breadth (moulded) over sponsons	26.0m	85.3 ft
Depth (moulded at centre line)	11.6 m	37.9 ft
Max height (above keel)	83.7 m	274 ft
Drill floor height above keel	22.5 m	73.8 ft
Height of main deck above keel	11.6 m	37.9 ft
Height from main deck to rig floor	10.9 m	35.7 ft
Height of derrick above rig floor	51.8 m	170 ft
Height from RKB to sea level	14.0 m	46 ft
Moonpool diameter	6.71 m	22 ft

Displacement		
Full load	20,253 mt	
Drilling	18,780 mt (Drilling, max load, deep hole, deep water)	
Variable load	6,687 mt	
Lightship	12,093 mt	
Tonnages		
Gross (International)	TBA tons	
Net (International)	TBA tons	
Draught		
Draft at load line	8.20 m	27 ft
Transit	8.02 m	(Fully loaded, operating, departure)
Drilling	7.67 m	
Lightship Draft (Mean)	5.80 m	(Lightship incl. perm. ballast, mean)
Helideck		
Location	Aft	
Dimensions	22.2 m - octagonal	
Maximum helicopter size	Sikorsky 61N & 92N	
Fuel storage	2 ea 720 gallon tanks	
Crane capacities		
Number of main cranes	2	
Manufacturer/Type	National OS435	
Boom length	120 ft	
Max hoisting capacity at maximum boom	14.75 mt	
Max hoisting capacity at minimum boom	71.3 mt	
Accommodation		
Number of beds	124	
Number of Hospital beds	4	
Sewage Treatment Unit	Hamworthy	
Propulsion equipment		
Propeller	1 ea 15' 7" diameter, fixed blade	
Propulsion Drive Unit	Marine Diesel, 6 cylinder, 2 Cycle, Crosshead type	
Manufacturer Type	UBE Mitsubishi UEC	
Horsepower	7,200 hp @ 135 RPM	
Speed, Intermittent, Calm Sea	TBA	
Speed, Continuous, Calm Sea	TBA	
Fuel Consumption	TBA	
Thrusters	1 each Bow Thruster 1 each Dual Stern Thruster	

Mooring equipment

Anchor pattern symmetric 8 points system. The unit is fitted with Sonat Offshore Drilling patented roller turret mooring system giving the unit the ability to maintain favorable heading without an interruption of the drilling operations.

Anchors Manufacturer	Vryhoff
Weight	7t Stevpris New Generation
Anchor Lines	Chain Wire Combination
Size/Grade	2 ¾"wire 3"ORQ chain
Length	2750 feet wire 500 feet chain- each leg
Breaking Strength	TBA
Anchor Winches	4 x Smatco Model 90-HTD-150 Double Drum
Max Continuous Pull	300,000 lbs
Brake Capacity	610,000 lbs (on pawls)
Drive System	Hydraulic Electro Winch Driven by 2 ea 150 hp AC Motors
Chain Lockers	4
Fairleads	8 ea Skagit, Vertically Mounted
Standard "J" hook chasers	2
Roller "J" hook chasers	2
Standard Chain Grapple	2
Anchor Tension Instrumentation	Brake and Hydraulic Motor Load Monitoring System

Operating water depth

Max Water Depth	1,000 ft with present equipment (can be outfitted to 2,500ft)
Max Drilling Depth	20,000 ft

Drilling package

Draw works	Ideco E-2100, 2,000 hp
Rotary	National C-495 with 49 1/2" opening
Mud Pumps	2 x Continental Emsco Model FA-1600 Triple Mud Pumps
Derrick	Pyramid 170 ft with 1,300,000 lbs nominal capacity
Pipe Racking	BJ 3 arm system
Drill Sting Compensator	Shaffer 400 K x 18 ft stroke
Riser tensioners	8 x 80K Shaffer 50 ft stroke tensioners
Crown Block	Pyramid with 9 each 60" diameter sheaves rated at 1,330,000 lbs
Travelling block	Continental - Emsco RA60-6
BOP	Cameron 18 3/4 " x 10,000 psi
Riser	Cameron RCK type
Top Drive	Varco TDS-3S, with GE-752 motor, 500 ton
BOP handling	Hydraulic skid based system, drill floor

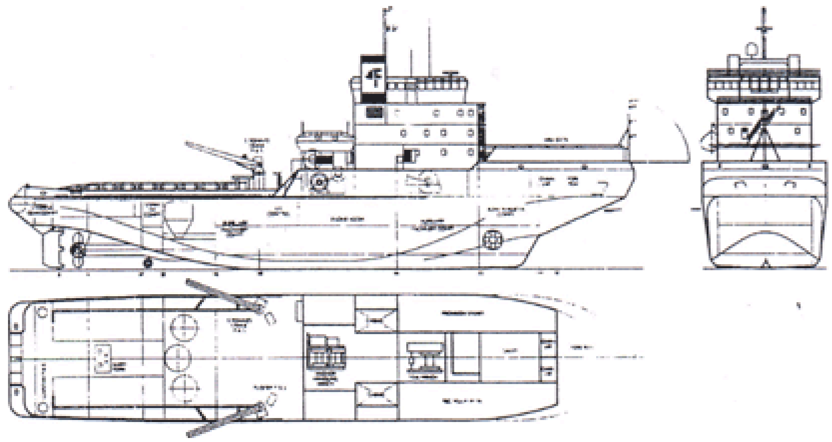
General storage capacities

Pipe Rack Capacity	TBA
Sack Storage Area	934 m^3
Bulk Storage (Bentonite/Barite)	180 m3 – 4 tanks
Bulk Cement	180 m3 – 4 tanks
Liquid Mud	Active 1,200 bbls Reserve 1,200 bbls Total 2,400 bbls
Potable Water	1,670 bbl / 265.5 m^3 (aft peak can be used as add. pot water tank)
Drill Water	5,798 bbl / 921.7 m^3
Fuel Oil	6,497 bbl / 1,033 m^3 (2S, 2P, 3S, 3P, 4S and 4P upper wings can be used as additional fuel storage or well test crude tankage)
Hospital	2 Examination berths, 4 recovery berths
Six-man rooms	nil
Four-man rooms	nil
Two-man rooms	59 (all ensuite)
Single rooms	6 (all ensuite)

APPENDIX 3 – ICE MANAGEMENT VESSEL SPECIFICATIONS

Figure 1 - M/V Vladimir Ignatjuk

The "Vladimir Ignatjuk" Diesel Icebreaker



Wharf - builder: Victoria Yard, Burrard Yarrrows Corporation, Canada
.

Purpose: Multifunctional icebreaker-tow

Class: Lloyd's Register of Shipping + 100 A1 Icebreaker Tug + LMC
Lloyd's Register of Shipping 100 A1 LMC, icebreaking tow, ice class - 1A Super

Max. length: 88.02 m

Width: 17.51 m

Draught: 8.3 m

Deadweight capacity: 2,113 t

Displacement: 7,077 t

Main engine: Two-shaft diesel-reduction gear engine with 4 main engines and variable-pitch propeller.
GD type - 8TM410, Stork Werkspoor Diesel

Capacity of engine: 4 x 5,800 h/p

Maximal speed in clear water: 15.5 knots

Navigation area: unlimited

Figure 2 - M/V Kapitan Dranitsyn

Table 1 M/V Kapitan Dranitsyn Specifications

Vessel name:	Kapitan Dranitsyn	Vessel Performance and Capabilities	
Vessel nationality:	Russia	Cruising speed (knots, open water):	16
Vessel owner:	Russian Federation	Range in nautical miles:	10500
Vessel operator:	Murmansk Shipping Company	Range in km:	19500
Primary Logistics Provider		Fuel capacity:	2,800 tons of IFO 30 for the main diesels
Organization:	Murmansk Shipping Company	600 tons of MGO for auxiliary generator sets	
Address:	Murmansk Shipping Company	Propulsion power:	16,200 KW DC electric
15, Kominterna str.		Icebreaking capability:	1.5 meters at 1 knot, 3 meters ramming
RU-183836 Murmansk		**Accommodations**	
Russia		Crew berths:	60
Tel.: + 7 8152 52 50 68		Scientist berths:	102
Telex: 126113 mrf ru		Winches, Wires and Cables	
Vessel Characteristics		From the expedition log of the NABOS 2003 cruise:	
Vessel length in meters:	132	**Other Science Features**	
Vessel length in feet:	433	Other science-related features:	Helicopter deck
Beam (Breadth) in meters:	27		
Beam in feet:	89		
Draft in meters:	8.5		
Draft in feet:	28		
Displacement GRT:	15000		
Year built:	1982		

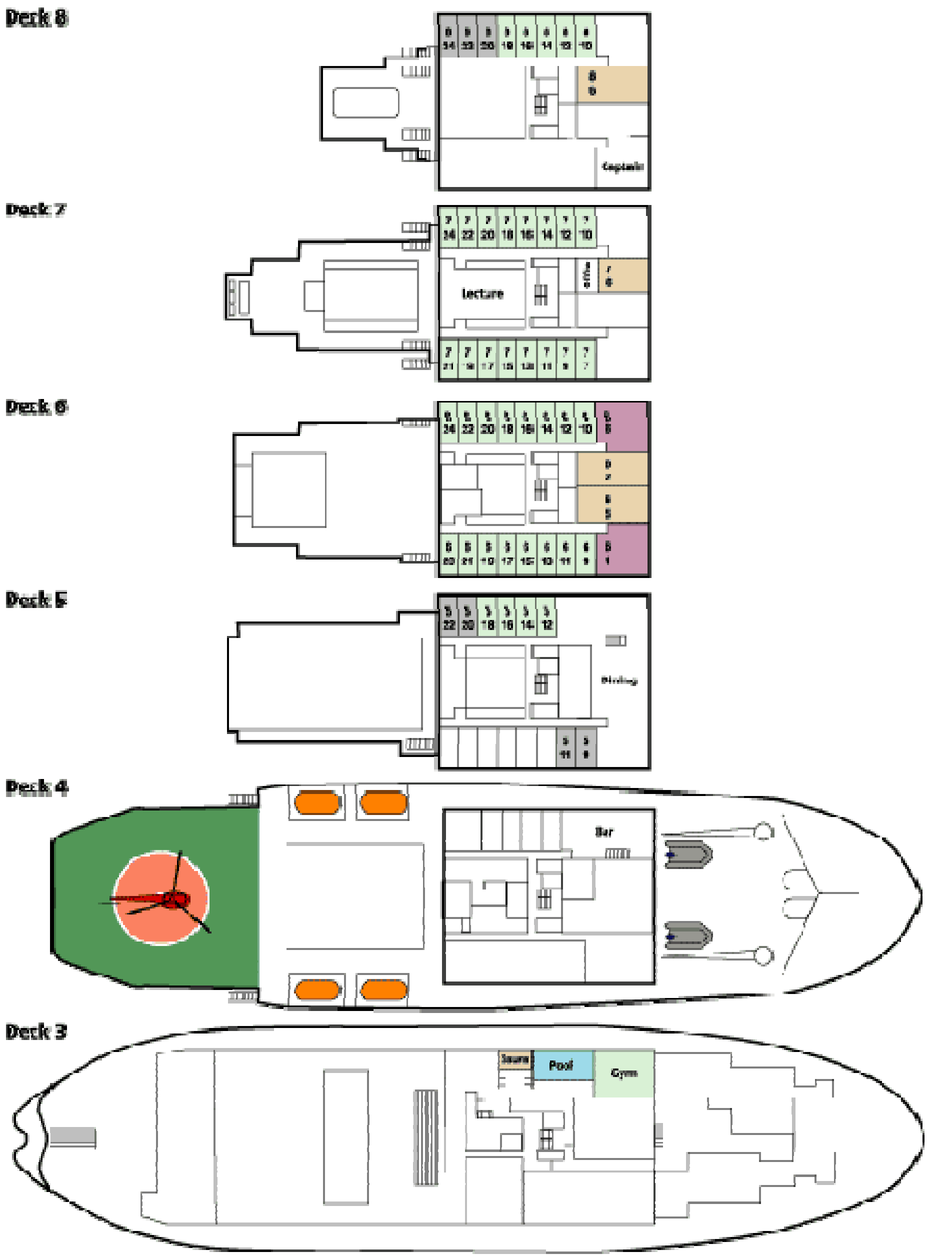


Figure 2b - M/V Kapitan Dranitsyn: Layout

Figure 3 - M/S Fennica – M/S Nordica

MULTIPURPOSE ICEBREAKER

M/S FENNICA   M/S NORDICA

CLIENT: THE NATIONAL BOARD OF NAVIGATION, Finland

MAIN PARTICULARS:

Length oa.	115.0 m	**TDW, offshore**	4500 t
Breadth	25.0 m	**Engine power**	20 000kW
Depth	13.0 m	**Propulsion motors**	2 x 7 500 kW
Draught, icebreaker	7.0 m	**Bow Thrusters**	3 x 1 150 kW
Draught, offshore	8.4 m	**Speed**	16 kn
TDW, icebreaker	1 650 t	**Personnel max**	82

COMMISSION:

-Project design
-Model tests
-Contract documents
-Inspection of basic design documents

Figure 4 - M/V Tor Viking

TOR VIKING

LLMX

ANCHOR HANDLING TUG SUPPLY VESSEL - ICEBREAKER

Class: DNV, +1A1, Tug/Supply Vessel, SF, E0, Icebreaker ICE 10, Heldk-SH, W1-OC, Official No: IMO 7410814

Dimensions and particulars

Delivered 2000 by Havyard Leirvik AS, Norway

Main dimensions:

Length o.a	83,70 m
Length between perp.	75,20 m
Beam	18,00 m
Depth to main deck	8,50 m
Draft, scantling	7,20 m
Draft, design	6,00 m
DWT	3 000 mt on 7,2 m
GT	4 000 mt
NT	1 200 mt

Deck capacities:

Deck area	603 m2 (40,2 x 15,00)
Deck load	1 350 mt (VCG 1,0 m)
Deck strength	5-10 mt/m2
Cargo rail height	3 000 mm
Bulwark height	1 200/1 500 mm

Cargo tank capacities and discharge rates:

Dry bulk	4 tanks, tot 283 m^3 2x25 m^3/h compressors-80 psi Two discharge systems Discharge rate 2x75 t/h at 90 m head
Potable water	724 m^3
Drillwater/ballast	1 113 m^3
Brine (sg 2,5)	400 m^3
Liquid mud (sg 2,8)	657 m^3
Base oil	242 m^3
Marine Gas Oil	1190 m^3
Diesel overflow	21 m^3
Diesel service/settl	2 x 20 m^3

Machinery:
2 x MAK 8M32 in line (father) 3840 kW
2 x MAK 6M32 in line (son) 2880 kW
Total of 18 300 HP (13 440 kW)

Main propellers:
Two KaMeWa 4 blades in nozzle, dia 4 m, 145 rpm

Rudders:
Two spade rudders, 2 x 45 deg, split or synchronized

Bow thrusters:
One Brunvoll tunnel 1200 BHP
One Brunvoll nozzle rotatable/retractable 1200 BHP

Stern Thrusters:
One Brunvoll tunnel 1200 BHP

Speed and Consumption:
16 knots (72%) - 42,7 mt per 24 hrs
12 knots (23%) - 15,6 mt per 24 hrs
10 knots (13%) - 8,6 mt per 24 hrs

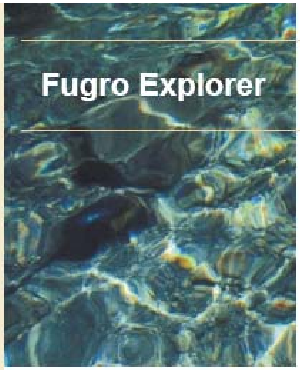
Bollard Pull:
Min 200 tonnes continuous forward
Min 120 tonnes continuous astern

Auxiliary engines and generators:
Two shaft generators powered by the "sons"
Two diesel harbour generators sets, each 400 kW
Emergency generator, 130 kW
Supply system: 690/400/230V - 50Hz

Towing/Anchor handling equipment:
AHT winch Brattwag BSL 400 WX/SL 400 WX,
400 tonnes pull - 550 tonnes brakeholding
One AHT drum, declutchable with dividing
One AHT drum, off declutchable
Cable lifters, Rig chain lockers, 2 x rope reels
Stern roller, SWL 500 tonnes
Shark jaw, SWL 500 tonnes

APPENDIX 4 – GEOTECHNICAL BOREHOLE DRILLING

FUGRO EXPLORER SPECIFICATIONS



Fugro Explorer

The Fugro Explorer is Fugro's new technologically advanced geotechnical vessel, equipped with the latest drilling, soil sampling and in-situ testing equipment, capable of operating in water depths up to 3,000m. The vessel was built in 1999, completely refitted and delivered in July 2002.

The Fugro Explorer has been specifically designed to meet the challenges of operating in today's deepwater markets. The vessel is fully equipped for geotechnical, geological/stratigraphic and reservoir characterization investigations. The Fugro Explorer is capable of undertaking long duration projects in severe operating conditions, fulfilling our client's data acquisition needs worldwide.

SAMPLING AND IN-SITU TESTING

The Fugro Explorer has the latest of Fugro's technologically advanced sampling and testing equipment. The vessel carries Fugro's versatile Dolphin suite of tools able to perform downhole sampling, piezocone penetration tests (PCPTs) and in-situ vane testing. The vessel also carries the newly developed Fugro Hydraulic Piston Corer, which is deployed in a downhole mode, and is capable of taking undisturbed continuous downhole piston samples in up to 10m lengths.

The Fugro Explorer uses its unique Seabed Wheeldrive System to perform continuous PCPT profiling as well as T-bar and in-situ vane tests. A jumbo piston corer, deployed from the stern of the vessel, can provide up to 25m cores.

The Fugro Explorer also has a 1,300 square foot geotechnical laboratory and office facility, providing for a full suite of geotechnical tests and onboard report production.

DRILLING SYSTEMS

The Fugro Explorer has a 90ft derrick with 150 metric ton load capacity and traction winches that allow for seabed sampling/testing operations in water depths of up to 3,000m.

The vessel has a 5½ inch Dreco top drive system, Hydraudyne heave compensation system and a one-of-a-kind automated pipe handling unit.

DYNAMIC POSITIONING

The Fugro Explorer is equipped with a Kongsberg/Simrad DPII system. The system is coupled with a positioning system which accepts input from DGPS, taut wire and the onboard USBL system. Weather down time is minimized as the system enables the vessel to weathervane and continue uninterrupted operations through marginal operating conditions.

For more information on the Fugro Explorer or any of Fugro's other vessels contact Fugro today or log onto:

www.fugro.com.

Attachment B Marine Mammal Monitoring and Mitigation Plan

DRAFT

MARINE MAMMAL MONITORING AND MITIGATION PLAN

for

Seismic Exploration and Exploratory Drilling of Selected Lease Areas in the Alaskan Beaufort Sea

LGL Alaska Research Associates, Inc.
LGL Limited environmental research associates

Attn: Dr. Dale Funk
1101 East 76th Avenue, Suite B
Anchorage, Alaska 99518
907-562-3339 (Telephone)
907-562-7223 (FAX)
dfunk@lgl.com

Prepared for

Shell Offshore Incorporated

January 2007

DRAFT

MARINE MAMMAL MONITORING AND MITIGATION PLAN

For

Seismic exploration and exploratory drilling of selected lease areas in the Alaskan Beaufort Sea

Prepared by

LGL Alaska Research Associates, Inc.
LGL Limited environmental research associates

Attn: Dr. Dale Funk
1101 East 76th Avenue, Suite B
Anchorage, Alaska 99518
907-562-3339 (Telephone)
907-562-7223 (FAX)
dfunk@lgl.com

Prepared for

Shell Offshore Incorporated

January 2007

TABLE OF CONTENTS

INTRODUCTION

Shell Offshore Incorporated (SOI) has contracted LGL Alaska Research Associates, Inc. (LGL) to design and conduct a Marine Mammal Monitoring and Mitigation Program (MMMMP) for seismic acquisition and drilling activities in the Beaufort Sea during the ice-covered and open-water periods of 2007. The goal of the MMMMP is to develop a program that supports protection of the marine mammal resources in the area, fulfills reporting obligations to the Minerals Management Service (MMS), the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS), and provides useful baseline data on marine mammals for future operations planning.

SOI plans to conduct seismic acquisition operations (1) detailed vessel-based, 3D seismic surveys during the open water period and (2) vessel-based, shallow hazard site assessment within the project area using towed airgun/telemetry arrays. The 3D seismic surveys will be conducted in the Beaufort Sea using the MV *Gilavar* as the seismic source vessel from August to late October depending upon ice conditions. The *Gilavar* will be accompanied by a chase vessel. The shallow hazard survey vessel will operate in the Beaufort Sea simultaneously with the 3D seismic acquisition vessel. A third vessel will be used to re-supply the *Gilavar*, the chase vessel, and the shallow-hazards survey vessel and to transfer personnel.

In addition to the seismic acquisition and shallow hazards surveys, SOI plans to conduct exploratory drilling within existing lease holdings in the Beaufort Sea. Drilling will be conducted from two drill ships. One drill ship, the Shell owned *Kulluk* submersible drilling platform will access the Alaskan Beaufort Sea from Canada in early July or as soon as open water conditions will permit vessel traffic. The other drilling ship, the Frontier Drilling owned *Discoverer* drill ship will access the Beaufort Sea from the Chukchi Sea. The drilling ships are ice-class drilling vessels designed, engineered and constructed to safely operate in the Beaufort Sea. The drill ships will require several ice management support vessels, all of which will have some level of ice-breaking capability.

SOI also plans to conduct a brief series of geotechnical borings employing a third and much smaller drill vessel during late August and September. All drilling activities will be focused on a geographically limited area at the western edge of Camden Bay.

The MMMMP will consist of monitoring and mitigation during the ice-covered and open-water seismic activities, the shallow hazards site assessment activities, and the exploratory drilling activities. Monitoring will provide information on the numbers of marine mammals potentially affected by these activities and permit real time mitigation to prevent injury of marine mammals by seismic or other industrial sounds or activities. These goals will be accomplished by conducting vessel- and sea-ice based, aerial, and acoustic monitoring programs to characterize the sounds produced by the drilling and seismic operations and to document the potential reactions of marine mammals in the area to those sounds and activities. Acoustic modeling will be used to predict the sound levels produced by the seismic, shallow hazards, and drilling equipment in the Beaufort Sea. Acoustic measurements will also be made to establish safety radii for real time mitigation around the activities. Aerial monitoring and reconnaissance of marine mammals and recordings of ambient sound levels, vocalizations of marine mammals, and received levels of seismic operations, should they be detectable using bottom-founded acoustic recorders along the Beaufort Sea coast will be used to interpret the reactions of marine mammals exposed to the activities.

UNDERWATER ACOUSTIC PROGRAM

This section presents a plan for the preparation, conduct, analysis and reporting of underwater sound measurements in support of SOI seismic surveys and exploratory drilling in the Beaufort Sea during the ice-covered and open-water seasons of 2007. Sounds from the vessel-based seismic airgun array and shallow hazards equipment, other low- and/or mid-frequency noise produced from the source vessel and other support vessels, and sounds produced during the drilling operation will be measured in the field during typical operations. These measurements will be used to establish safety and disturbance radii for marine mammals groups within the project area.

Background

JASCO Research Ltd. will estimate the distances from the vessel-based airgun arrays on the source vessel and the shallow hazards vessel to various broadband received levels including 190, 180, 170, 160, and 120 dB_{rms} re 1 μPa using their modeling program. JASCO will also model the sound produced during drilling activities and estimate the various disturbance radii based on sound propagation of the drill ships and associated equipment. The model will estimate the broadband sound propagation in water in relation to various environmental and physical characteristics. Prior to the start vessel-based seismic acquisition and drilling activities, Greeneridge or JASCO will measure the sound propagation from the various seismic sources and drilling equipment. The results of these measurements will be used to determine the actual sizes of the various safety and disturbance radii that will be used for mitigation during the seismic and drilling activities.

Objectives

The objectives of the planned work are (1) to measure the distances from the various sound sources to broadband received levels of 190, 180, 170, 160, and 120 dB_{rms} re 1 μPa, and (2) to measure the radiated vessel sounds vs. distance for the source and support vessels. The measurements will be made at the beginning of the specific activity (i.e., vessel based seismic activity, shallow hazards survey activity, and drilling activity) and all safety and disturbance radii will be reported within 72 hours of completing the measurements. For the drilling operation a subsequent mid-season assessment will be conducted to measure sound propagation from combined drilling operations during "normal" operations. The primary radii of concern will be the 190 and 180 dB safety radii for pinnipeds and cetaceans, respectively, and the 160 dB disturbance radii. In addition to reporting the radii of specific regulatory concern, distances to other sound isopleths down to 120 dB (if measurable) will be reported in increments of 10 dB. The distance at which received sound levels become ≥120 dB for continuous sound (which occurs during drilling activities as opposed to impulsive sound which occurs during seismic activities) is sometimes considered to be a zone of potential disturbance for some cetacean species by NMFS. SOI plans to use vessel-based marine mammal observers (MMOs) to monitor and implement mitigation measures for the 190 and 180 dB safety radii and the 160 dB disturbance radii around the seismic sound sources. MMOs will also monitor the 120dB zone around the drilling ships. An aerial survey program will be implemented to monitor the 120 dB zone around the seismic and drilling activities in the Beaufort Sea in 2007. These two monitoring and mitigation programs are discussed in separate sections below.

Vessel-based Seismic Activities

Airgun Source and Vessel Measurement

For the airgun array, the source measurement program will be designed to capture high resolution recordings from the airgun array source pressure waveforms as a function of distance and direction from the array. Measurements will be made by qualified acousticians such as Greeneridge Sciences, Inc. or JASCO using bottom founded hydrophone systems. The systems provide an autonomous recorder that is deployed on the seabed using an acoustic release system. The recorder will be deployed along a survey track ahead of the vessel to capture the airgun array sound as the survey vessel approaches, passes over, and departs from the recording location. The vessel will also travel to the side of the recorder at various distances to measure airgun sounds in relation to distance in the broadside direction (at right angles to vessel travel). In addition to the airgun array, the bottom founded units will also measure noise from the seismic vessel and support (chase) vessels. The bottom founded units are ideal for the water depths present over the entire survey region. These systems were used during measurements of sound propagation of the SOI airgun array at the beginning of the 2006 field season in the Chukchi Sea. A detailed description of the systems is located in SOI’s 2006 monitoring plan.

Field analysis and reporting

Data will be previewed in the field immediately after download from the instruments. This approach will ensure that good-quality data are being received throughout the field program. Brief daily reports will be issued to the seismic operators by electronic mail when that capability is available. An initial sound source analysis will be supplied to NMFS and the seismic operators within 72 hours of completion of the measurements, if possible. A detailed report will be issued to NMFS as part of the 90 day report following completion of the seismic program.

Vessel-based Drilling Activities

SOI plans to use a qualified acoustical contractor such as Greeneridge or JASCO to measure the sound propagation of the vessel-based drilling rigs during periods of drilling activity, and the drill ships and support vessels while they are underway at the start of the field season. Noise from ships with ice-breaking capabilities will be measured during periods of ice-breaking activity. These measurements will be used to determine the sound levels produced by various equipment and to establish any safety and disturbance radii if necessary. Bottom-founded hydrophones similar to those used for measurements of vessel-based seismic sound propagation will likely be used to determine the levels of sound propagation from the drill rigs and associated vessels. An initial sound source analysis will be supplied to NMFS and the drilling operators within 72 hours of completion of the measurements, if possible. A detailed report will be issued to NMFS as part of the 90 day report following completion of the drilling program.

Acoustic Monitoring Program

SOI plans to develop an acoustic component of the MMMMP to further understand, define, and document sound characteristics and propagation within the broader Beaufort Sea and potential deflections of bowhead whales from anticipated migratory pathways in response to vessel-based drilling activities. Of particular interest for this investigatory component is the east-west extent of deflection (i.e. how far east of a sound source do bowheads begin to deflect and how far to the west beyond the sound source does deflection persist). Of additional interest is the extent of offshore deflection that occurs.

In previous work around seismic and drill-ship operations in the Alaskan Beaufort Sea, the primary method for studying this question has been aerial surveys. The changes in distribution of bowhead whales as they approach and pass industrial activities have been documented to various degrees by past studies based on aerial surveys and observations of whale behavior and direction of travel at various distances from the activities. By combining data from several field seasons (1996-1998), Miller et al. (1999) documented that most bowheads avoided an active seismic program in the Beaufort Sea near Prudhoe Bay by at least 20 km, and some avoided the area within 30 km. The sighting rate just beyond 30 km from the seismic vessel was higher during periods of seismic operation, as whales appeared to be displaced from waters closer to the operation. The displacement probably began on the order of 35 km “upstream” (east) of the operation, but evidence for that specific distance was equivocal. With the available data, it was not possible to document how far after the whales passed the seismic vessel that they returned to their normal or pre-disturbance migratory path.

Less information is available on how vessel-based drilling noise similar to that proposed by SOI in the Beaufort Sea in 2007 may impact migrating bowhead whales. Determining the potential effects of drilling noise on migration bowhead whales will be complicated by the presence of ice-breaking and other support vessels that may contribute significantly to underwater sound levels. Miles et al. (1987) reported higher sound pressure levels from ice-breakers underway in open water than from vessel-based drilling activity. Sound pressure level levels from dredging activity, a working tug, and an icebreaker pushing ice were also greater than those produced by vessel-based drilling activity. However, some of these sounds, such as an icebreaker pushing ice, may have been intermittent rather than continuous. Sounds produced during drilling activity are relatively continuous, and there is some concern that continuous sound may have an impact at a greater distance than intermittent sound of the same intensity.

Acoustic localization methods provide a possible alternative to aerial surveys for addressing these questions. As compared with aerial surveys, acoustic methods have the advantage of providing a vastly larger number of whale detections, and can operate day or night, independent of visibility, and to some degree independent of ice conditions and sea state—all of which prevent or impair aerial surveys. However, acoustic methods depend on the animals to call, and to some extent assume that calling rate is unaffected by exposure to industrial noise. Bowheads do call frequently in fall, but there is some evidence that their calling rate may be reduced upon exposure to industrial sounds, complicating interpretation. Also, acoustic methods require development and deployment of instruments that are stationary (preferably mounted on the bottom) to record and localize the whale calls. Acoustic methods would likely be more effective for studying impacts related to a stationary sound source, such as a drilling rig that is operating within a relatively localized area, than for a moving sound source such as that produced by a seismic source vessel.

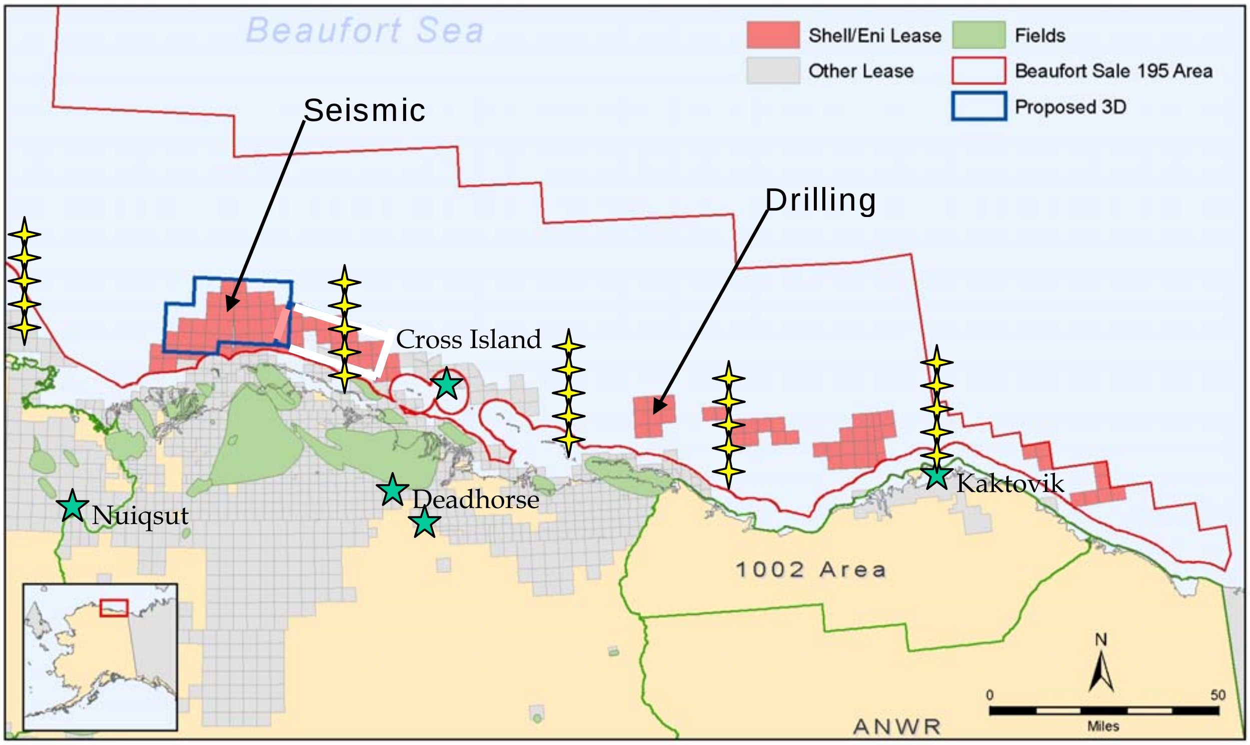
Approach

SOI plans to use an acoustic localization approach to assess whether there are patterns in the spatial and temporal distribution of whale calls that provide information about the nature and geographic extent of the effects of vessel-based drilling on migrating bowhead whales. An acoustic approach could, in theory, assess how far upstream and downstream one can detect some evidence of offshore (or inshore) deflection of the whale migration corridor at times influenced by ongoing or recent drilling activities, and/or the activities of support vessels. Results of an acoustic program to determine the effects of vessel-based drilling could provide information on the distances at which migrating bowhead are first deflected from their migratory path, when they return to their original path, and how far offshore a deflection might occur.

SOI and other industry participants initiated an acoustic monitoring program in the Chukchi Sea in support of offshore seismic exploration in 2006. The acoustic "net" array used during the 2006 field season in the Chukchi Sea and was designed to (1) collect information on the occurrence and distribution of beluga whales that may be available to subsistence hunters near villages located on the Chukchi Sea coast, and (2) measure the ambient noise levels near these villages and record received levels of sounds from seismic survey activities should they be detectable. The basic components of this effort consisted of bottom-founded equipment for long-duration passive acoustic recording. A suite of autonomous seafloor recorders was deployed in a "net" array extending from nearshore to approximately 50 miles offshore.

SOI plans to conduct a similar study in 2007 to determine the effect of drilling noise and noise from support vessels and seismic activities on migrating bowhead whales. Bottom-founded acoustic recorders that have the ability of recording calling whales will be deployed around SOI's drilling activities during the 2007 drilling program. Fig. 1 shows potential locations of the bottom-founded recorders and an array layout in relation to the drilling site. The actual locations of the bottom-founded recorders will depend on specifications of recording equipment chosen for the project, and on the acoustical characteristics of the environment, which are yet to be determined. The results of these data will be used to determine the extent of deflection of migrating bowhead whales from the sound sources produced by the vessel-based drill rig. These results will be reported in a Comprehensive Report in spring 2008.

Figure 1. Proposed acoustic recorder net array near hypothetical drill locations in the Camden Bay area.



AERIAL SURVEY PROGRAM

Objectives

An aerial survey program will be conducted in support of the seismic exploration and drilling programs in the Beaufort Sea during summer and fall of 2007. The objectives of the aerial survey will be:

- to advise operating vessels as to the presence of marine mammals in the general area of operation;
- to monitor the area east of the seismic activity to ensure that large numbers of bowhead mothers and calves do not enter the area where they would be ensonified by seismic sounds >120 dB re 1µPa, which might displace them from feeding areas or their preferred migratory routes,
- to collect and report data on the distribution, numbers, movement and behavior of marine mammals near the seismic and drilling operations with special emphasis on migrating bowhead whales;
- to support regulatory reporting and Inupiat communications related to the estimation of impacts of seismic and drilling operations on marine mammals;
- to monitor the accessibility of bowhead whales to Inupiat hunters and

- to document how far west of seismic and drilling activities bowhead whales travel before they return to their normal migration paths, and if possible, to document how far east of seismic and drilling operations the deflection begins.

Survey Considerations

Different aerial survey designs will be implemented during the summer (August) and fall (late August–October) periods because the numbers and distributions of marine mammal species of primary interest are different during those periods. During the early summer, few cetaceans are expected to be encountered in the Beaufort Sea, and those that are encountered are expected to be either along the coast (gray whales) or among the pack ice (bowheads and belugas) north of the area where seismic surveys and drilling activities are to be conducted. During some years a few gray whales are found feeding in shallow nearshore waters from Barrow to Kaktovik but most sightings are in the western part of that area.

During the late summer and fall, the bowhead whale is the primary species of concern, but belugas and gray whales are also present. Bowheads and belugas migrate through the Alaskan Beaufort Sea from summering areas in the central and eastern Beaufort Sea and Amundsen Gulf to their wintering areas in the Bering Sea. Small numbers of bowheads are sighted in the eastern Alaskan Beaufort Sea starting mid-August and near Barrow starting late August but the main migration does not start until early September. The bowhead migration tends to be through nearshore and shelf waters, although in some years small numbers of whales are seen near the coast and/or far offshore. Bowheads frequently interrupt their migration to feed and their stop-overs vary in duration from a few hours to a few weeks. A commonly used feeding area is in and near Smith Bay, east of Barrow. Less consistently used feeding areas are in coastal and shelf waters near and east of Kaktovik.

The aerial survey procedures will be generally consistent with those during earlier industry studies (Davis et al. 1985; Johnson et al. 1986; Evans et al. 1987; Brueggeman et al. 1992; Miller et al. 1997, 1998, 1999; LGL 2006). This will facilitate comparison and pooling of data where appropriate. However, the specific survey grids will be tailored to SOI's operations and the time of year. During the 2007 field season we will coordinate and cooperate with the aerial surveys conducted by MMS and any other groups conducting surveys in the same region, as we have when conducting aerial surveys on behalf of industry and MMS.

It is understood that the timing, duration, and location of SOI's seismic, and to a lesser extent, drilling operations are subject to change as a result of unpredictable weather and ice issues, as well as regulatory and stakeholder concerns. The recommended approach is flexible and able to adapt at short notice to changes in the seismic operations.

Safety Considerations

Safety considerations will be of primary importance in all decisions regarding the planning and conduct of the aerial surveys. Safety-related considerations during planning have included choice of aircraft, aircraft operator, and pilots; outfitting of the aircraft; lengths and locations of survey grids; and safety training. Safety-related considerations during aerial survey operations will include careful and judicious consideration of weather; and avoidance of flight in questionable conditions. Although the pilots will have ultimate authority, the aerial survey crew will also be required to make their own judgments and to avoid flying in questionable circumstances. To this end, the aerial survey teams will have extensive experience (~5000 h in the case of the team leader) with this type of survey flying in arctic conditions, and will have the authority to cancel or (in agreement with the pilots) amend flight operations as necessary for safety.

Survey Procedures

Flight and Observation Procedures

Standard aerial survey procedures as used by ourselves and others in many previous marine mammal projects will be followed. This will facilitate comparisons and (as appropriate) pooling with other data, and will minimize any controversy about the chosen survey procedures. The aircraft will be flown at 120 knots ground speed and usually at an altitude of 1000 ft. Surveys in the Beaufort Sea are directed at bowhead whales and an altitude of 900-1000 ft is the lowest survey altitude that can normally be flown without concern about potential aircraft disturbance; it is also the altitude recommended for IHA monitoring efforts for bowhead whales. Aerial surveys at an altitude of 1000 ft do not provide much information about seals but are suitable for both bowhead and beluga whales. The need for a 900-1000+ ft cloud ceiling will limit the dates and times when surveys can be flown. Selection of a higher altitude for surveys would result in a significant reduction in the number of days where surveys would be possible, impairing the ability of the aerial program to meet its objectives.

One of the observers will be seated behind the copilot. Safety guidelines by Shell Aviation require that the copilot occupy the copilot’s seat. This is a variation from most earlier surveys where a primary observer was seated in the copilot’s seat allowing for better forward visibility and access to radio and navigation equipment. The bubble windows that are currently available in survey aircraft largely mitigate for the reduced visibility in the rear seat; during earlier surveys bubble windows were not available, or if they were available, they were not as well designed and visibility was not as good.

The second observer will be seated behind the pilot and a third observer will be seated behind the copilot’s position. The third observer will observe part time and record data the rest of the time. All observers need bubble windows to facilitate downward viewing. For each marine mammal sighting, the observer will dictate the species, number, size/age/sex class when determinable, activity, heading, swimming speed category (if traveling), sighting cue, ice conditions (type and percentage), and inclinometer reading. The inclinometer reading will be taken when the animal’s location is 90° to the side of the aircraft track, allowing calculation of lateral distance from the aircraft trackline.

Transect information, sighting data and environmental data will be entered into a GPS-linked data logger by the third observer, and simultaneously recorded on audiotape for backup and validation. At the start of each transect, the observer recording data will record the transect start time and position, ceiling height (ft), cloud cover (in 10ths), wind speed (knots), wind direction (°T) and outside air temperature (°C). In addition, each observer will record the time, visibility (subjectively classified as excellent, good, moderately impaired, seriously impaired or impossible), sea state (Beaufort wind force), ice cover (in 10ths) and sun glare (none, moderate, severe) at the start and end of each transect, and at 2-min intervals along the transect. This will provide data in units suitable for statistical summaries and analyses of effects of these variables (and position relative to seismic vessel) on the probability of detecting animals (see Davis et al. 1982; Miller et al. 1999; Thomas et al. 2002).

The data logger will automatically record time and aircraft position (latitude and longitude) for sightings and transect waypoints, and at preselected intervals along the transects. The primary data logger will be a laptop computer with Garmin Mapsource (ver 6.9) data logging software. Mapsource automatically stores the time and aircraft position at pre-selected intervals (typically between 2-6 sec for straight-line transect surveys) as they are obtained from the GPS unit.

If marine mammals are seen within any "safety zone" around the seismic source vessel or drill ship, or heading toward that zone, the aerial observers will notify personnel on the vessel by radio so that the sighting can be monitored and a power down or shut down the airgun array initiated if necessary. If a large aggregation of bowhead mothers and calves (defined in the 2006 IHA as four or more mother-calf pairs during a survey) is seen approaching the seismic operation, the seismic operation will be shut down before they enter the area where they would be exposed to seismic sounds >120 dB re 1 µPa. Once surveys confirm that the aggregation has left the area (i.e., fewer than four mother-calf pairs are seen on a survey), seismic operations will be resumed.

Selection of Aircraft

Specially-outfitted Twin Otter aircraft are expected to be the survey aircraft. These aircraft will be specially modified for survey work and have been used extensively by NMFS, ADF&G, COPAC, NSB, and LGL during many marine mammal projects in Alaska, including LGL projects as recent as 2006. These types of aircraft have been found to be very suitable for survey work, and are safer than potential alternatives. Among the essential or desirable features are standard IFR instrumentation, STOL kit, radar altimeter with output for computerized data recording, high wing, dual GPS systems with output for computerized data recording, bubble windows, VHF/SSB/FM radios, AC inverter, high-quality intercom, active noise-canceling headsets, adjustable seating positions, and movable computer desk. Endurance depends on fuel tank configuration, load and airspeed, but is generally 3.25 to 6.5 h after allowance for one hour of fuel reserves. The aircraft needs a comprehensive set of survival equipment appropriate to offshore surveys in the Arctic; the suggested aircraft are provided with the appropriate gear. For safety reasons, the aircraft should be operated with two pilots.

Avoiding Fatigue

The size of the survey grids planned for late August–October 2007 are comparable in total length to grids flown during earlier industry surveys. The planned surveys will require up to 8 hours of flying per day, depending on the survey grid. A single team of observers cannot survey for that many hours on a daily basis without becoming fatigued and missing more mammals than normal. This is especially so when good flying weather persists for 2 or 3 days in a row. Fatigue is exacerbated by the need to spend considerable time on the ground coordinating with other vessel-based and aerial field crews in the morning and evening, and organizing each day's data for the required evening transmissions to MMS and NMFS. To minimize the fatigue problem, during periods when daily surveys are required (mid-September–October), a four or five-person aerial survey crew will be used: two primary observers; data-logger/secondary observer; and one or two additional alternate observers. The alternates will rotate observation duties with the other three observers, and will share the coordination and data summarization responsibilities. It will often be feasible for the "extra" observers to remain on the ground, with rotation occurring when the aircraft lands to refuel or for a brief break. However, at some times the off-duty observers will need to ride in the aircraft and rotate while in flight. During times when surveys are less intensive, e.g., August and early September, a three-person survey crew will be used. Inupiat observers were trained as observers during our 2006 surveys and one or more Inupiat observers will be present during surveys. Use of additional Inupiat observers (trainees) will further reduce fatigue associated with conducting the long survey routes.

Supplementary Data

Weather, ice and sightability data will be recorded systematically during all surveys. Percent ice cover and severity of sun glare will be recorded by each primary observer for every 2-minute interval along transects. Ice observations during aerial surveys will be mapped when ice is present and satellite imagery will be used, where available, to document ice conditions adjacent to the survey area. These are standard practices for surveys of this type, and are necessary in order to interpret factors responsible for variations in sighting rates.

We will, as a high priority, assemble the information needed to relate marine mammal observations to the shooting schedule and locations of the seismic vessel or drillship, and to the estimated received levels of industrial sounds at mammal locations. Data on the shooting schedule, seismic tracklines, and heading of the seismic vessel will be obtained from records maintained by the seismic contractor and some of the information will be available from data recorded by the marine mammal observers on the seismic source vessel (see earlier). During the aerial surveys, we will record relevant information on other industry vessels, whaling vessels, low-flying aircraft, or any other human activities that are seen in the survey area.

Coordination with MMS Aerial Surveys

The Minerals Management Service is planning to continue its wide-ranging aerial surveys of bowhead whales and other marine mammals in the Beaufort Sea during the autumn of 2007 (Dr. C. Monnett, MMS, pers. comm.). Their surveys include the Beaufort Sea part of the SOI study area. SOI will co-ordinate with MMS to obtain access to their data, both during the field season and for use in analyses and reports.

SOI will also consult with MMS regarding coordination during the field season and real-time sharing of data. The aims will be

- to ensure aircraft separation when both crews conduct surveys in the same general region [note this would also apply to the UAS described below];
- to coordinate the 2007 aerial survey projects in order to maximize consistency and minimize duplication;
- to use data from MMS's broad-scale surveys to supplement the results of the more site-specific SOI surveys for purposes of assessing seismic effects on whales and estimating "take by harassment";
- to maximize consistency with previous years' efforts insofar as feasible;

It is expected that raw bowhead sighting and flightline data will be exchanged between MMS and LGL on a daily basis during the field season, and that each team will also submit its sighting information to NMFS in Anchorage each day. After the SOI and MMS data files have been reviewed and finalized, they will be exchanged in digital form. These practices will be consistent with what has been done in the past, and will likely be required by permits and authorizations.

We are not aware of any other related aerial survey programs presently scheduled to occur in the Alaskan Beaufort Sea in areas where SOI is anticipated to be conducting seismic during Jul./Oct. 2007. However, one or more other programs are possible in support of other anticipated industry and research operations. If another aerial survey project were planned, SOI or LGL (with SOI's approval) would seek to coordinate with that project to ensure aircraft separation, maximize consistency, minimize duplication, and share data.

Surveys during Seismic Acquisition

Survey Design in Beaufort Sea in Summer

The main species of concern in the Beaufort Sea is the bowhead whale but small numbers of belugas, and in some years, gray whales, are present in the Beaufort Sea during summer (see above). Few bowhead whales are expected to be found in the Beaufort Sea during early August; however, a reduced aerial survey program is proposed during the summer prior to seismic operations to confirm the distribution and numbers of bowheads, gray whales and belugas, because no recent surveys have been conducted at this time of year. The few bowheads that were present in the Beaufort Sea during summer in the late 1980s were generally found among the pack ice in deep offshore waters of the central Beaufort Sea (Moore and DeMaster 1998; Moore et al. 2000). Although gray whales were rarely sighted in the Beaufort Sea prior to the 1980's (Rugh and Fraker 1981), sightings appear to have become more common along the coast of the Beaufort Sea in summer and early fall (Miller et al. 1999; Treacy 1998, 2000, 2002; LGL 2007) possibly because of increases in the gray whale population and/or reductions in ice cover in recent years. Because no summer surveys have been conducted in the Beaufort Sea since the 1980s, the information on summer distribution of cetaceans will be valuable for planning future seismic or drilling operations. The grid that will be flown in the summer will have more-widely-spaced lines than the grid that will be flown during the fall period and will extend farther offshore to document the offshore distribution of bowhead whales and belugas (Fig. 2). If cetaceans are encountered in the vicinity of planned seismic operations, then in consultation with SOI, we would consider flying the survey grid proposed for later in the season (see Fig. 3) rather than the one shown in Fig. 2. Surveys will be conducted 2 days a week until the period one week prior to the start of seismic operations in the Beaufort Sea. Beginning approximately one week prior to the start of seismic operations, daily surveys would be initiated and they would be conducted using the grid shown in Figure 3.

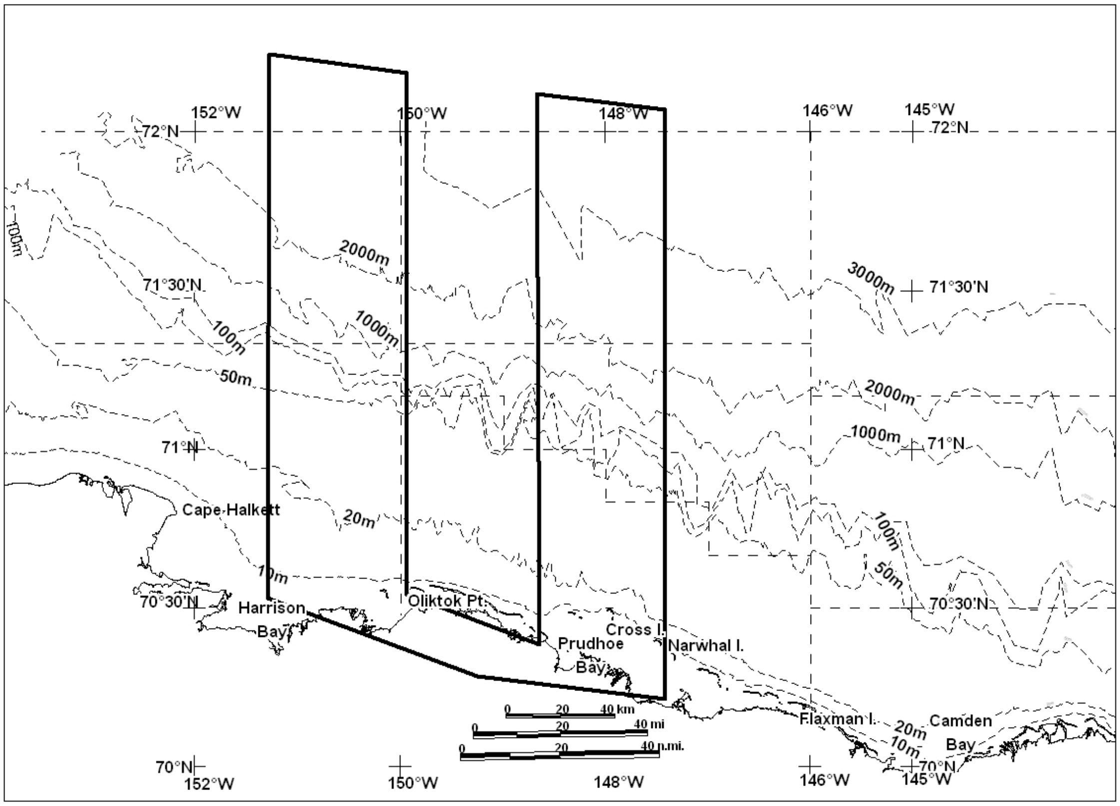


FIGURE 2. Central Alaskan Beaufort Sea showing aerial survey lines that will be flown 2 days a week during summer if seismic surveys were centered on the middle of the grid. Survey grids will be moved east or west depending on the location of the seismic surveys.

Survey Design in Beaufort Sea in Fall

Aerial surveys during the late August-October period will be designed to ensure that large aggregations of mother-calf bowheads do not approach to within the 120 dB re 1µPa radius from the active seismic operation. At the same time, they will obtain detailed data (weather permitting) on the occurrence, distribution, and movements of marine mammals, particularly bowhead whales, within an area that extends about 100 km to the east of the primary seismic vessel to a few km west of it, and north to about 65 km offshore (Fig. 2). This site-specific survey coverage will complement the simultaneous MMS/BWASP survey coverage. The proposed survey grid will provide data both within and beyond the anticipated immediate zone of influence of the seismic program, as identified by Miller et al. (1999). Miller et al. (1999) were not able to determine how far upstream and downstream (i.e., east and west) of the seismic operations bowheads began deflecting and then returned to their "normal" migration corridor. That is a key concern for the Inupiat whalers and to some degree to NMFS. The proposed survey grid is not able to address that concern because of the mitigation need to extend flights well to the east to detect mother-calf pairs before they are exposed to seismic sounds >120 dB re 1 µPa.

It is possible that the east-west extent of seismic surveys will change during the season due to ice or other operational restrictions. If so, the aerial survey grid will have to be modified to maintain observations to 100 km east of the seismic survey area, but the total km of survey that can be conducted each day are limited by the fuel capacity of the aircraft. The only alternative to ensure adequate aerial survey coverage over the entire area where seismic activities might influence bowhead whale distribution is to space the individual transects farther apart. For each 15-20 km increase in the east-west size of the seismic survey area, the spacing between lines will need to be increased by 1 km to maintain survey coverage from 100 km east to 20 km west of the seismic activities.

Data from the easternmost transects of the proposed grid will document the main bowhead whale migration corridor east of the seismic exploration area and will provide the baseline data on the location of the migration corridor relative to the coast.

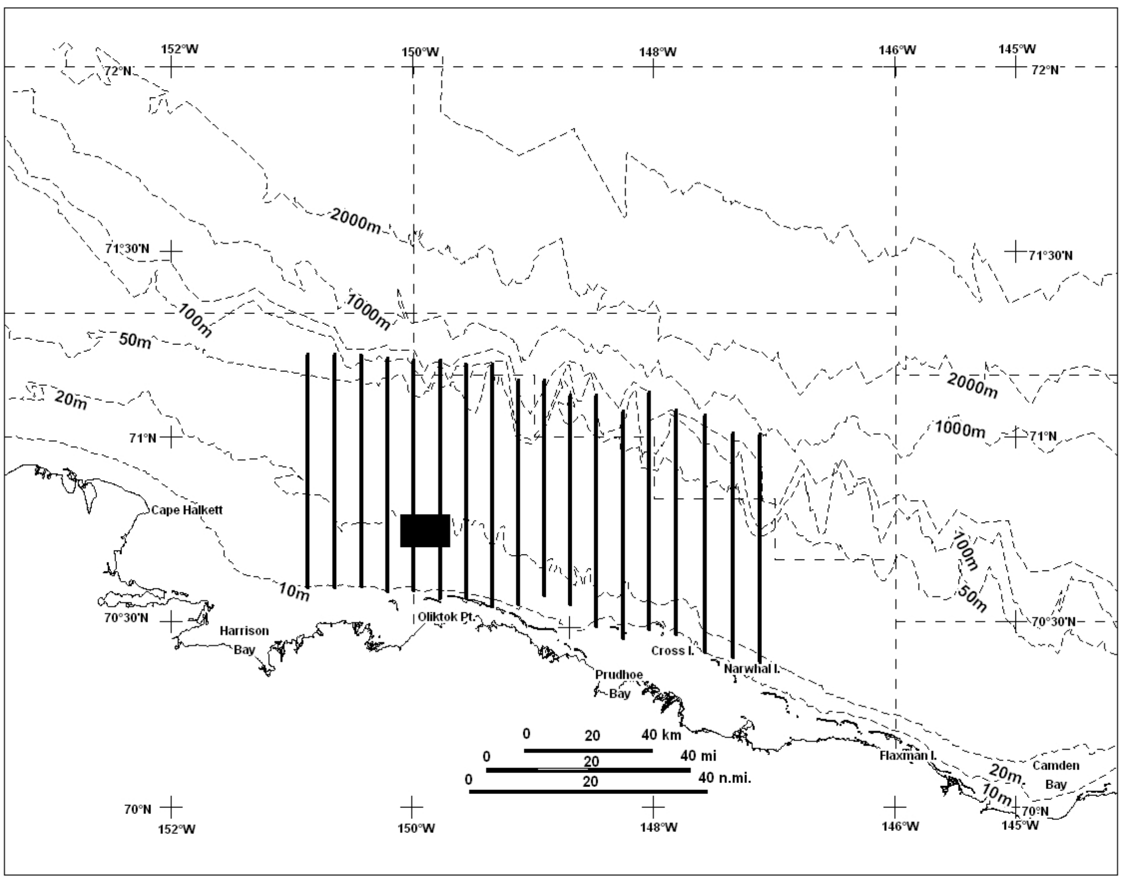


FIGURE 3. Central Alaskan Beaufort Sea showing aerial survey lines during fall if seismic surveys were conducted in the area of the back square (seismic survey area). Survey grids will be moved east or west depending on the location of the seismic surveys.

We do not propose to fly a smaller "intensive" survey grid in 2007. In most previous years, a separate grid of 4-6 shorter transects was flown, whenever possible, to provide additional survey coverage within about 20 km of the seismic operations. This coverage was designed to provide additional data on marine mammal utilization of the actual area of seismic exploration and immediately adjacent waters. The 1996-98 studies showed that bowhead whales were almost entirely absent from the area within 20 km of the active seismic operation (Miller et al. 1997, 1998, 1999). Thus, the flying-time that (in the past) would have been expended on flying the intensive grid will be used to extend the coverage farther to the east and west of the seismic activity.

If seismic surveys of the Beaufort Sea end while substantial numbers of bowhead whales are still migrating west, aerial survey coverage of the area of most recent seismic operations will continue for several days after seismic surveys have ended. This will provide "post-seismic" data on whale distribution for comparison with whale distribution during seismic periods. These data will be used in analyses to estimate the extent of deflection during seismic activities and the duration of deflection after surveys end. Post-seismic coverage will not be conducted if the bowhead migration has ended by that time, but it is expected that due to freeze-up, seismic operations will move out of the Beaufort Sea before the end of the bowhead whale migration.

Survey Grids

Two different aerial survey grids are proposed depending on whether surveys are being conducted during summer (July to late August) or fall (late August–October). During summer, four north-south lines spaced 48 km apart and centered on the planned seismic exploration area would be flown 2 times each week (Fig. 2). They would extend from the barrier islands (or 10-m contour in areas with no barrier islands) north to about 72°N which may be well within the pack ice at that time of year. The proposed survey grid for late August–October consists of up to 18 north-south lines spaced 8 km apart and will extend to 100 km east of the then-current seismic exploration area. Lines will extend from the barrier islands (or 10-m contour) north to approximately the 100 m depth contour. As previously described, when the seismic program moves east or west, the aerial survey grids will also be relocated a corresponding distance along the coast. This grid will be flown 2 times each week until one week prior to the start of seismic surveys. They will then be flown daily until one week after the end of seismic surveys in the Beaufort Sea. The eastern boundary of the survey area will extend eastward beyond the 120 dB radius of seismic sounds in order to detect aggregations of mother-calf pairs approaching the seismic operation.

Depending on the distance offshore where seismic is being conducted, the survey grid that is shown may not extend far enough offshore to document whales deflecting north of the operation. In this case, the north ends of the transects will be extended farther north so that they extend 30-35 km north of the seismic operation and the two most westerly lines will not be surveyed. This will mean that the survey lines will only extend as far west as the seismic operation. It is not possible to move the survey grid north without surveying areas south of the seismic operation because some whales may deflect south of the seismic operation and that deflection must be monitored. During previous studies of offshore drilling operations, bowhead whales were documented migrating near the coast <20 km south of a drilling operation (Koski and Johnson 1986). It would be desirable to monitor whale movements west of the seismic operation to document how far west bowheads move before returning to their normal migratory corridor. It is not possible, however, to monitor the 120 dB radius east of the seismic operation and obtain information on the distribution of whales west of the operation because of the large area that must be surveyed to the east.

The summer grid will total about 1000 km in length, requiring 4.6 h to survey at a speed of 220 km/h (120 knots), plus ferry time which will vary according to the location of the survey grid relative to the logistics base. The late August–October grid will total about 1300 km in length, requiring 6 h to survey at a speed of 220 km/h (120 knots), plus ferry time. Exact lengths and durations will vary somewhat depending on the east-west position of the seismic operations area and thus of the grid, the sequence in which lines are flown (often affected by weather), and the number of refueling/rest stops.

As during previous studies, we propose that, while whaling is underway we will not survey the southern portions of survey lines over or near hunting areas unless the whalers agree that this can be done without interfering with their activities. This will reduce (but not eliminate) the potential for overflying whalers and whales that are being approached by whalers. Some of the autumn bowhead sightings in the region do occur in this “nearshore” area, and these whales will not be documented if the survey aircraft remains 15+ km offshore in this area at all times. If we do not survey this area while whaling is occurring, we will reduce the potential for aircraft-whaler interactions at the expense of reducing our ability to assess seismic effects on bowheads, other marine mammals, and subsistence activities in that nearshore area.

Transect Positions and Sequence

For the purposes of this project, which primarily concern migrating bowheads, the transect lines in the grid should be oriented north-south, equally spaced, and at consistent locations from day to day relative to the location of seismic operations. Bowhead whale movements during the late summer/autumn are generally from east to west, and transects should be designed to intercept rather than parallel whale movements.

Weather permitting, transects making up the grid in the Beaufort Sea will be flown in sequence from east to west. Although this increases difficulties associated with double counting of whales that are (predominantly) migrating westward, the main purpose of these surveys is to detect concentrations of mother-calf pairs that might be approaching the seismic survey area. If we start on the western side we would minimize our potential to detect those animals before they were exposed to seismic sounds >120 dB. However, if cloud, fog or high sea-state prevents coverage of the eastern part of the grid early in the day, the western portion will be surveyed first. If, after that is done, conditions on the eastern portion have become tractable, they would then be surveyed from east to west.

Surveys during Drilling Activities

Survey Design in the Beaufort Sea in Summer

As noted above, few cetaceans are expected to be found in the central and western Beaufort Sea during summer. A few gray whales may be found in nearshore areas during years with light ice cover. Most belugas and bowheads in the central and western

Beaufort Sea during summer will be offshore amongst the pack ice. Thus the aerial survey program planned for the summer period will be the same survey pattern as shown in Figure 1. Surveys will start about a week before drilling operations begin and will be conducted twice a week. If unexpectedly large numbers of cetaceans are seen near drilling activities during the summer, the survey pattern will be altered to more closely resemble the fall pattern shown in Figure 3 and the frequency of surveys will be increased to 3-4 times per week.

Survey Design in the Beaufort Sea in Fall

Past studies have suggested that most migrating bowhead whales will avoid offshore drilling operations by 10-20 km (Koski and Johnson 1987; Davies 1997), although some whales will approach closer to the activity. Furthermore, studies by Davies (1997) suggest that changes in bowhead distribution due to drilling activities did not extend beyond 20 km west of the drilling operation. As a consequence, the survey pattern around drilling operations are designed to document whale distribution from about 40 km east of the drilling operations to about 40 km west of operations (Fig. 3). Surveys will be conducted daily starting in late August, if drilling operations are being conducted at that time. If drilling operations do not start until later in the season, daily aerial surveys will begin 2-3 days before drilling operations start.

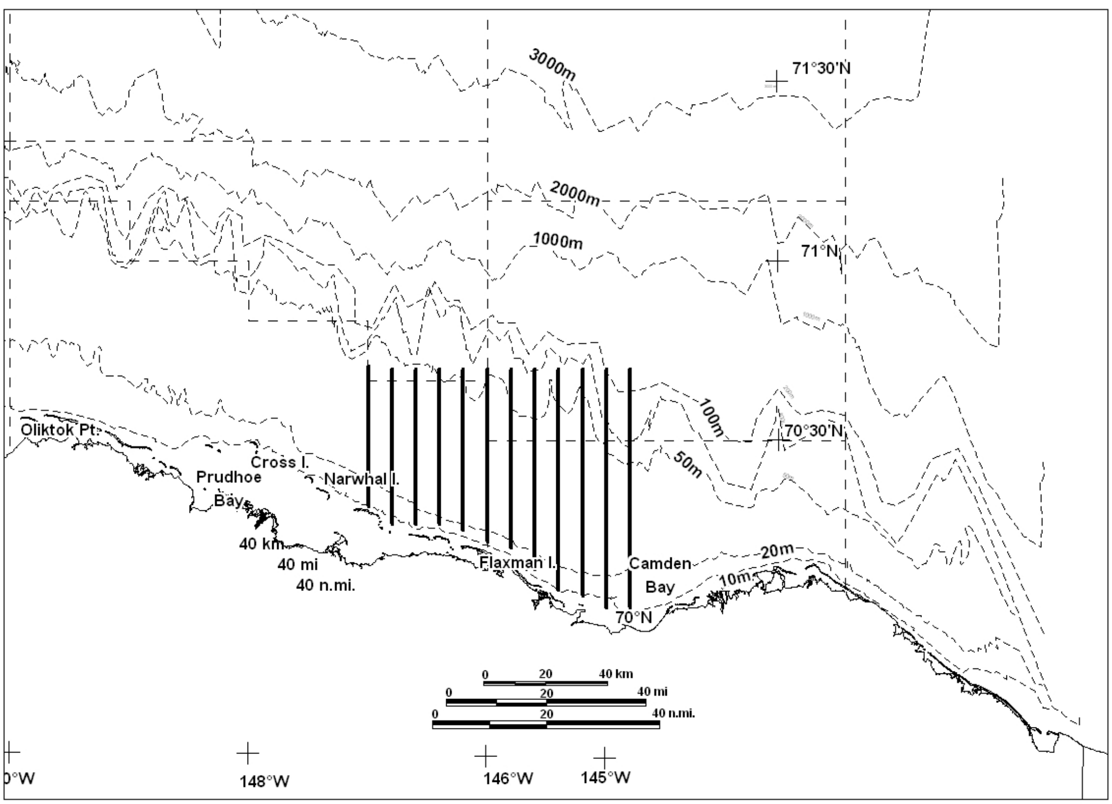


FIGURE 3. Central and eastern Alaskan Beaufort Sea showing aerial survey lines during fall if a drillship were operating north of Flaxman Island.

Survey Grids

Two different aerial survey grids are proposed depending on whether surveys are being conducted during summer (July to late August) or fall (late August–October). The same grid that is proposed for surveys associated with seismic surveys (Fig. 2) would be flown around drilling operation during the summer. If larger-than-expected numbers of cetaceans were seen, the fall grid pattern would be implemented.

During fall, a series of 12 north-south transects would be flown daily, weather permitting. The transects would be ~8 km apart, would be centered on the drilling operation, would extend 60-80 km offshore, and would be flown from west to east (Fig. 3). If two drilling locations are operating (as planned) grids would be centered over each of the operations.

The summer grid will total about 1000 km in length, requiring ~4.6 h to survey at a speed of 220 km/h (120 knots), plus ferry time which will vary according to the location of the survey grid relative to the logistics base. The late August–October grid will also total about 1000 km in length, requiring ~4.6 h to survey at a speed of 220 km/h (120 knots), plus ferry time. Exact lengths and durations will vary somewhat depending on the position of the drilling operation and thus of the grid, the sequence in which lines are flown (often affected by weather), and the number of refueling/rest stops.

As discussed above, we propose that, while whaling is underway we will not survey the southern portions of survey lines over or near hunting areas unless the whalers agree that this can be done without interfering with their activities.

Transect Positions and Sequence

For the purposes of this part of the project, which primarily concern migrating bowheads near drilling activities, the transect lines in the grid should be oriented north-south, equally spaced, and at consistent locations from day to day relative to the location of drilling operations. Bowhead whale movements during the late summer/autumn are generally from east to west, and transects should be designed to intercept rather than parallel whale movements.

Weather permitting, transects making up the grid in the Beaufort Sea will be flown in sequence from west to east. This decreases difficulties associated with double counting of whales that are (predominantly) migrating westward. The survey sequence around the drilling operation is different than that around the seismic operation because the objectives of the surveys are different. In this case, we are monitoring the distribution of whales around the drilling operation, and during seismic operations, surveys are designed to prevent mother-calf pairs from approaching close enough to the seismic operation that they would be exposed to seismic sounds >120 dB re 1 µPa. That is, surveys around seismic operation are conducted for mitigation, and surveys around drilling operations are conducted for monitoring.

Surveys using Unmanned Aerial Systems

Shell is investigating the use of an unmanned aerial system (UAS) for monitoring marine mammal distribution and movements near offshore oil and gas activities. An UAS consists of an unmanned aerial vehicle or drone (UAV), a launch and recovery system, and a ground control system (GCS). The use of UASs would reduce the risk to human life and may permit operations during some periods where manned flights would not be possible because of low ceilings or because they are too far from land for aircraft to operate safely. If deployed in 2007, the UAS would not be the primary data collection method to monitor bowhead movements near a drilling operation or a seismic operation, but it would provide additional data to those collected during the manned surveys.

The primary objectives of the UAS surveys would be

(1) To collect parallel information on whale sightings to those collected during the manned surveys.

(2) To conduct tests of detection rates of simulated whale targets from manned surveys and UAS surveys.

(3) To test viability of UAS operations during periods when manned surveys could not be conducted.

(4) To collect information on ice conditions near offshore operations.

The UAS will provide similar data on positions and numbers of various species of cetaceans to the manned surveys and the survey patterns will be the same. The major difference between the two platforms is that the transect width during UAS operations will be narrower (~600 m vs ~2000+ during manned surveys). To make up for the narrower search area, flight durations of the UAS can be longer (up to 20 hours without refueling) and the UAV is quiet so surveys can be conducted without disturbing whales when ceilings are <1000 ft.

Analysis of Aerial Survey Data

During the field program preliminary maps and summaries of the daily surveys will be provided to NMFS and AEWC, as normally required by the terms of the IHA and Conflict Avoidance Agreement. While in the field, data will be checked, data files will be backed up onto CDs, and data files will be transferred each day (if possible) to a secure FTP site where they can be accessed by LGL data analysts for validation and further processing of the data. Two levels of analyses will be conducted. The first level will consist of basic summaries that are required for the 90-d report(s) specified by the IHA(s). These include summaries of numbers of marine mammals seen, survey effort by date, maps summarizing sightings, and estimates of numbers of marine mammals that are "taken" according to NMFS criteria. The second level of analyses will be presented in the subsequent technical report. The technical report will provide more detailed analyses of the data to quantify the effect of the seismic program on the distribution and movements of marine mammals. The latter analyses will emphasize the bowhead whale, which is the primary species of concern to NMFS and AEWC in the Beaufort Sea region.

Estimation of Numbers "Taken"

LGL has developed methods for estimating the numbers of marine mammals that are "taken" (as defined by NMFS) for past studies in the Beaufort Sea and Chukchi regions (Miller et al., 1999; Haley and Ireland 2006) and for other areas of the world (Lawson et al. 1998; Holst et al. 2005; Ireland et al. 2005). These estimates require estimating the numbers of animals present near or passing the seismic and drilling programs during periods without seismic or drilling and assuming that similar numbers would have passed during those activities if the activities were not conducted. The planned approach has been accepted by NMFS as satisfying the requirements for "take" estimates for numerous previous seismic monitoring programs.

The main purposes of the 2007 aerial programs insofar as the IHA requirements are concerned are to monitor the area east of the seismic operation to prevent large numbers of mother-calf pairs from being subjected to seismic sounds >120 dB re 1 µPa, to provide the data needed to determine how many marine mammals of each species were "taken by harassment" by the seismic and drilling programs, to document the nature of those "takes", to estimate their likely consequences for the marine mammal populations, and to determine whether there was any effect on the accessibility of marine mammals to subsistence hunters. NMFS requires these data to ensure that the seismic and drilling programs had no more than a negligible impact on species or stocks of marine mammals, and no unmitigable adverse impact on their availability for subsistence hunting. The data to be collected by the vessel-based observers, aerial surveys, and acoustic programs, and the associated analyses of these data, in conjunction with prior years' data, will provide the needed information.

The criteria to be used in tabulating and estimating numbers of cetaceans potentially exposed to various sound levels will be consistent with those used during previous related projects in 1996-2005 unless otherwise directed by NMFS. Only cetaceans will be addressed using the aerial survey data because the altitude of the surveys is too high to reliably detect and identify pinnipeds. As in previous studies, we anticipate that there will be four components:

1. *Numbers of cetaceans observed within the area ensonified strongly by the seismic vessel and drilling operations.* For cetaceans, we will estimate the numbers of animals exposed to received rms levels of seismic sounds exceeding 120, 160 dB and 180 dB re 1 µPa, as required by NMFS. In the Beaufort Sea, received levels may exceed 160 dB (rms) out to several kilometers from a seismic vessel (Greene and Richardson 1988; Greene and Moore 1995; Greene 1997). We will also estimate the number of cetaceans exposed to received levels ≥180 dB (rms). This is the received level above which there is some suspicion that seismic pulses might affect hearing sensitivity or perhaps some other physiological processes of baleen whales (NMFS 1995, 2000; HESS 1999).

2. *Numbers of cetaceans observed showing apparent reactions to seismic pulses or drilling operations, e.g., heading in an "atypical" direction.* Animals exhibiting apparent responses to the activities will be counted as affected by the programs if they were exposed to sounds from those activities.

3. *Numbers estimated to have been subject to sound levels ≥120, ≥160 and ≥180 dB re 1µ Pa (rms) when no monitoring observations were possible*. This will involve using the

observations from the survey aircraft (SOI/LGL and MMS), supplemented by relevant vessel-based observations, to estimate how many cetaceans were exposed, over the full course of SOI's 2007 seismic and drilling programs, to situations where exposures to ≥120, ≥160 and ≥180 dB were likely. In the case of the bowhead whale, we will estimate the proportions of the observed whales that were, simultaneously, close enough to shore to have passed through the area where exposure might occur, and could have passed while seismic or drilling operations were underway. Our aerial survey design, together with the complementary aerial surveys to be conducted by MMS, will provide the needed data.

4. *The number of bowheads whose migration routes came within 20 km of the operating seismic vessel or drilling activity, or would have done so if they had not been displaced farther offshore, will be estimate*d. If the 2007 data indicate that the avoidance distance exceeds 20 km, the larger avoidance distance will also be used. These estimates will be obtained by determining the displacement distance based on the aerial survey results, and then estimating how many bowheads were likely to approach the avoided area during times while the airgun array was operating or the drillship and support vessels were present. This method was used in previous years to estimate the number of bowheads that may have avoided the area within 20 km of the seismic operations (Miller et al. 1998, 1999).

Location of Migration Corridor

The location of the bowhead migration corridor in 2007 will be determined by examining data from periods with no seismic or drilling activities and data from east of those operations. The MMS aerial survey data will be a useful supplement for areas well east of the seismic program. We will contrast the numbers of bowhead sightings and individuals vs. distance from shore

- during periods with vs. without operations, and
- near vs. east vs. west of the exploration areas.

The distance categories will be linked to received sound levels based on the results from the acoustic measurement task. Analyses will be done on a sightings-per-unit effort basis to allow meaningful interpretation even though aerial survey effort is inevitably inconsistent at different distances offshore.

Effects of Seismic Program on Bowhead Migration Corridor

To determine how far east, north and west displacement effects extend, additional analyses will be conducted on bowhead sightings and survey effort in relation to distance and bearing from the operations during times with and without operations. We anticipate applying a logistic or Poisson regression approach to assess the effects of distance and direction from the operating airguns and drilling operations on sighting probability of bowhead whales, allowing for the confounding influence of sightability (sea state, ice conditions, etc) and other covariates. We have already used that approach extensively in analyses of whale and seal distribution in the Beaufort Sea (Manly et al. 2004; Moulton et al. 2005). Biostatistician Dr. Trent McDonald of WEST, who was instrumental in some of these past analyses, will assist with analyses of marine mammal data. Other analyses that may be useful to describe the effects of the seismic operation on the bowhead migration path, including summaries of headings, behavior and swimming speeds, will be included in the technical report.

The data from the current survey may not provide enough sightings to be able to quantify the effects of SOI's 2007 activities on the bowhead whale migration path. That could occur if SOI's operations in the Beaufort Sea during the bowhead whale migration season were limited due to ice or other factors, or if 2007 is a year when weather conditions were poorer than average, which would limit the periods when surveys could be conducted. The 2007 data collection will be nearly identical to earlier seismic programs in 1985-2006, which will allow future pooling of data from all studies.

The aerial survey data pertaining to other species of marine mammals will also be mapped and analyzed insofar as this is useful. However, the main migration corridor of belugas is far offshore, and generally north of the area to be surveyed in the surveys proposed here. Few gray whales and walruses are likely to be seen because of their rarity in the Beaufort Sea area (although gray whales were seen in the area in 1998[Miller et al. 1999] and small numbers have been seen during several recent surveys by MMS (Treacy 1998, 2000, 2002) and LGL (2007). Therefore, the proposed aerial surveys are expected to document the infrequent use of continental shelf waters of the Beaufort Sea by beluga whales, gray whales and walruses, and detailed analyses for these species probably will not be warranted. Seals cannot be surveyed quantitatively by aerial surveys at altitudes 900 to 1500 ft over open water. The aerial surveys will provide only incidental data on the occurrence of bearded and especially ringed seals in the area.

VESSEL-BASED MARINE MAMMAL MONITORING PROGRAM

Introduction

The vessel–based operations will be the core of SOI's MMMMP. The MMMMP will be designed to meet the requirements of the IHA(s) issued by the NMFS for this project, and to meet any other stipulation agreements between SOI and other agencies or groups. The objectives of the program will be to ensure that disturbance to marine mammals and subsistence hunts is minimized, that effects on marine mammals are documented, and to collect baseline data on the occurrence and distribution of marine mammals in the study area. Those objectives will be achieved, in part, through the vessel-based monitoring and mitigation program.

The MMMMP will be implemented by a team of experienced marine mammal observers (MMOs), including both biologists and Inupiat personnel. The MMOs will be stationed aboard the seismic source and support vessels, and on the two drilling vessels and associated support vessels throughout the seismic exploration and drilling period. The duties of the MMOs will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the seismic operations; initiating mitigation measures when appropriate; and reporting the results. Reporting of the results of the vessel-based monitoring program will include the estimation of the number of "takes", as stipulated in the IHA.

The vessel-based operations of SOI's MMMMP will be required to support 3-D and shallow hazard seismic source vessels, and the vessel based drilling activities in the central and eastern Alaskan Beaufort Sea (August through October). The dates and operating areas will depend upon ice and weather conditions, along with SOI's arrangements with agencies and stakeholders. Seismic operations and drilling activities are expected to occur during August and October 2007. Vessel-based monitoring for marine mammals will be done throughout the period of seismic and drilling operations to comply with anticipated provisions in the IHA(s) that SOI expects to receive from NMFS and USFWS.

The vessel-based work will provide

- the basis for real-time mitigation (airgun power downs and, as necessary, shut downs), as called for by the IHA(s) that SOI receives,
- information needed to estimate the "take" of marine mammals by harassment, which must be reported to NMFS and USFWS,
- data on the occurrence, distribution, and activities of marine mammals in the areas where the seismic program is conducted,
- information to compare the distances, distributions, behavior, and movements of marine mammals relative to the source vessels at times with and without seismic activity,
- a communication channel to Inupiat whalers and the Whaling Coordination Center, and
- employment and capacity building for local residents, with one objective being to develop a larger pool of experienced Inupiat MMOs.

The MMMMP will be operated and administered consistent with MMS NTL 2004-G01 or such alternative requirements as may be specified in the IHA(s) issued by NMFS for this project. Any other stipulation agreements between SOI and agencies or groups such as MMS, USFWS, NSB, and AEWC will also be fully taken into account. All MMOs will be provided training through a program approved by NMFS and SEPCO, as described later. At least one observer on each vessel will be an Inupiat who will have the additional responsibility of communicating with the Inupiat community and (during the whaling season) directly with Inupiat whalers. Details of the vessel-based marine mammal monitoring program are described below.

Mitigation Measures during Seismic Acquisition and Drilling Activities

SOI's proposed seismic exploration and offshore drilling programs incorporate both design features and operational procedures for minimizing potential impacts on marine mammals and on subsistence hunts. The design features and operational procedures have been described in the IHA applications submitted to NMFS and USFWS and are summarized below. Survey design features are

- timing and locating seismic and some drilling support activities to avoid interference with the annual fall bowhead whale hunts from Kaktovik, Nuiqsut (Cross Island), and Barrow;

- configuring the airgun arrays to maximize the proportion of energy that propagates downward and minimizes horizontal propagation;
- limiting the size of the seismic energy source to only that required to meet the technical objectives of the seismic survey;
- conducting pre-season modeling and early season field assessments to establish the appropriate 180 dB and 190 dB safety zones, and the 160 and 120 dB behavior radii; and
- vessel-based (and aerial) monitoring to implement appropriate mitigation and to determine the effects of project activities on marine mammals.

The potential disturbance of marine mammals during seismic and drilling operations will be minimized further through the implementation of several ship-based mitigation measures as discussed below.

Safety Zones

Under current NMFS guidelines (e.g., NMFS 2000), "safety radii" for marine mammals around airgun arrays are customarily defined as the distances within which received pulse levels are ≥ 180 dB re 1 μPa (rms) for cetaceans and ≥ 190 dB re 1 μPa (rms) for pinnipeds. These safety criteria are based on an assumption that seismic pulses received at lower received levels will not injure these animals or impair their hearing abilities, but that higher received levels might have some such effects. The NMFS will likely require safety zones for cetaceans at a distance within which continuous received levels from drilling operations are ≥ 120 dB re 1 μPa (rms). To our knowledge, a safety zone for pinnipeds around continuous sound sources has not been well established by NMFS.

Initial safety zones based on the sound levels produced by the airgun arrays on the seismic source vessel and the shallow hazards vessel will be established prior to the exploratory activities by modeling sound propagation based on the size and configuration of the airgun array and on available oceanographic data. Those safety zones will be used for mitigation purposes until direct measurements are available early during the seismic survey. An acoustics contractor will perform the direct measurements, using calibrated hydrophones, of the received levels of underwater sound versus distance and direction from the sound sources for both the seismic and drilling activities. The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify (and if necessary adjust) the safety distances. Mitigation measures as discussed below will be implemented if marine mammals are observed within or about to enter the appropriate safety radius.

RampUps

A ramp up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full volume is achieved. The purpose of a ramp up (or "soft start") is to "warn" marine mammals in the vicinity of the airguns and to provide the time for them to leave the area and thus avoid injury or impairment of their hearing abilities. Injury or impairment might occur if the full airgun arrays were fired suddenly and there were mammals nearby.

During the proposed SOI seismic program, the seismic operator will ramp up the airgun arrays slowly. Full ramp ups (i.e., from a cold start after a shut down, when no airguns have been firing) will begin by firing the smallest airgun in the arrays. The minimum duration of a shut-down period, i.e., without air guns firing, which must be followed by a ramp up typically is the amount of time it would take the source vessel to cover the 180-dB safety radius. That depends on ship speed and the size of the 180-dB safety radius, which are not known at this time. We estimate that period to be about 8-10 minutes. The IHA Application states that the duration of a full ramp up will be 20 minutes. However, NMFS has stipulated in some previous IHAs that, during any ramp up, the source level of the airgun arrays be increased by not more than 6 dB per 5-minute period. The duration of a full ramp up (i.e., the number of 5-minute periods) in that case will depend on the number of airguns firing prior to the ramp up (if any) and the size and number of airguns in the arrays. That may mean that the duration of a full ramp-up period will exceed the 20 minutes stated in the IHA Application.

A full ramp up, after a shut down, will not begin until there has been a minimum of a one half hour period of observation of the safety zone to assure that no marine mammals are present. The entire safety zone must be visible during the 30-minute lead-in to a full ramp up. If the entire safety zone is not visible, then ramp up from a cold start cannot begin. If a marine mammal(s) is sighted within the safety zone during the 30-minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for a specified time period—15 minutes for small odontocetes and pinnipeds, or 30 minutes for baleen whales and large odontocetes.

During periods of turn around and transit between seismic transects, one airgun will remain operational. The ramp-up procedure still will be followed when increasing the source levels from one air gun to the full arrays. However, keeping one air gun firing will avoid the prohibition of a cold start during darkness or other periods of poor visibility. Through use of this approach, seismic operations can resume upon entry to a new transect without a full ramp up and the associated 30-minute lead-in observations. MMOs will be on duty whenever the airguns are firing during daylight, which will be 24 h/day until mid-August. Therefore, at least during daylight periods, MMOs will always be observing during the 30-minute period preceding a ramp up from one airgun. The seismic operator and MMOs will maintain records of the times when ramp-ups start, and when the airgun arrays reach full power.

Power Downs and Shut Downs

A power down is the immediate reduction in the firing of the airgun array from all guns to one firing airgun. A shut down is the immediate cessation of firing of all airguns. The airgun arrays will be immediately powered down (i.e., reduced to one airgun firing) whenever a marine mammal is sighted approaching close to or within the applicable safety zone of the full airgun array, but is outside the applicable safety zone of the single airgun. If a marine mammal is sighted within the applicable safety zone of the single airgun, the airgun array will be shut down (i.e., no airguns firing). Although observers will be located on the bridge ahead of the center of the airgun array, the shutdown criterion for animals ahead of the vessel is based on the distance from the bridge (vantage point for MMOs) rather than from the airgun array – a conservative approach. For marine mammals sighted alongside the arrays, the distance is measured from the arrays.

Operations at Night and in Poor Visibility

When operating under conditions of reduced visibility attributable to darkness or to adverse weather conditions, infra-red or night-vision binoculars will be available for use. It is recognized, however, that their effectiveness for this application is very limited even in clear night time conditions.

Note that if one small airgun has remained firing, the rest of the array can be ramped up during darkness or in periods of low visibility. Seismic operations may continue under conditions of darkness or reduced visibility unless, in the judgment of the senior marine mammal observer, densities of endangered cetaceans in the general area are high enough to warrant concern that an endangered cetacean is likely to be in the safety zone undetected. In that case, observers will advise the Captain to halt airgun operations, or to move to a part of the survey area where visibility is adequate or where the likelihood of encountering an endangered cetacean is low based on aerial and vessel based surveys that would be part of the real-time monitoring program.

Marine Mammal Observers

Vessel-based monitoring for marine mammals will be done throughout the period of seismic operations to comply with expected provisions in the IHA(s) that SOI receives. Those provisions will be implemented during the seismic program by a team of trained MMOs. The observers will monitor the occurrence and behavior of marine mammals near the seismic vessel during all daylight periods when the airgun arrays are operating, and during most daylight periods when they are not operating. Their duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the seismic operations; advising seismic survey personnel of the presence of mammals within or approaching the designated "safety zones"; initiating mitigation measures (ramp ups, power downs, shut downs) when appropriate; and documenting "take by harassment" as defined by NMFS. In addition to meeting specific NMFS requirements, the vessel-based observations will be done in a manner consistent with that applied during the monitoring work for the 1998-2001 seismic projects in the Alaskan Beaufort for Western Geophysical (Moulton and Lawson 2002).

Number of observers

A sufficient number of MMOs will be required onboard each seismic source vessel to meet the following criteria

- 100% monitoring coverage during all periods of seismic operations in daylight, and for the 30 minutes prior to full ramp ups;
- coverage during darkness for 30-min before and during ramp-ups;
- maximum of 4 consecutive hours on watch per MMO;
- maximum of approx. 12 hours on watch per day per MMO;
- two-observer coverage during ramp ups and the 30 minutes prior to full ramp ups, and for as large a fraction of the other operating hours as possible.

To meet those criteria, SOI plans to place from two to five MMOs aboard each source vessel at any one time during all seismic operations. The specific number of MMOs during any period would depend on berthing availability, lifeboat space, day length, IHAs and other permit requirements, and the planned seismic operations. MMOs also require sufficient time for daily data entry, data checking, and other tasks aside from visual watches, and for sleep and meals.

MMO teams of two to five observers will consist of at least one Inupiat observer and one to three LGL biologists. An experienced field crew leader will be a member of every MMO team onboard the seismic source vessel during the seismic program. The total number of MMOs aboard may decrease later in the season as the duration of daylight decreases and if NMFS does not require continuous nighttime monitoring. Alternatively, the number of MMOs aboard may increase to five to provide training for additional Inupiat observers. If operations occur during the whaling season, the Inupiat observer(s) also will be employed as a part-time Communicator with whaling crews and with an industry/whaler coordination center. The requirement for, and role of, the Inupiat observers are expected to be defined in the "Conflict Avoidance Agreement" between SOI and the hunters.

Use of four (or five) observers aboard the main seismic vessel during the summer (i.e., during continuous daylight) will permit two observers to be on duty simultaneously for approximately 1/3rd of the hours when the airguns are in operation, and perhaps as much as 1/2 of the hours. (The specific fraction will depend on the consistency of airgun operations and other scheduling factors that are not fully predictable.) The fourth observer will rotate his/her schedule forward one hour each day such that, over the course of 12 days, there will be two-observer observation data throughout the 24 hour cycle (as well as during ramp-ups). Use of two observers at a time increases the effectiveness of monitoring by a significant amount (Harris et al. 1998; Moulton and Lawson 2002).

The observer team aboard the smaller shallow hazard source vessel will, if necessary, be assisted by personnel on the bridge to provide adequate monitoring coverage. That will be necessary if the shallow-hazards vessel operates for more than 12-16 hours per day.

Vessel-based Drilling Activities

Two drill ships will be used in the Beaufort Sea during the exploratory drilling activities in 2007. In addition to the two drilling ships, several support vessels will be required, each of which will contribute noise into the environment. These support vessels will include tugs and barges, and ice-breaking supply ships. Class III icebreakers have also been used during previous offshore drilling activities in the Arctic.

Sound produced during drilling operations will be continuous as opposed to the pulsed sound produced during seismic activities. Greene (1987) reported SPLs ranging from 130-136 dB (rms) at 0.2 km from the *Kulluk* during drilling activities (drilling, tripping, and cleaning) in the Arctic. Higher received levels up to 148 dB (rms) were recorded for supply vessels that were underway and for icebreaking activities. The exploratory drilling and the activities of the support vessels are not likely to produce sound levels sufficient to cause temporary hearing loss or permanent hearing damage to any marine mammals. Consequently, mitigation as described above for seismic activities including ramp ups, power downs, and shut downs should not be necessary for drilling activities. However, SOI plans to use MMOs onboard the drill ships and the various support and supply vessels to monitor marine mammals and their responses to industry activities. In addition, an acoustical program and an aerial survey program which are discussed in previous sections will be implemented to determine potential impacts of the drilling program on marine mammals.

Crew Rotation

SOI anticipates that there will be provision for crew rotation every six weeks. Should an unexpected crew rotation be required we will facilitate monitoring consistency by preparing detailed hand-over notes for the oncoming crew leader. If possible, there will also be communications (e.g., email, fax, and/or phone) between the current and oncoming crew leaders during each cruise.

Observer Qualifications and Training

Crew leaders and most other biologists serving as observers in 2007 will be individuals with experience as observers during one or more of the 1996-2001 seismic monitoring projects for Western Geophysical or BP, and/or subsequent seismic monitoring projects for other clients in Alaska, the Canadian Beaufort, or other offshore areas in more recent years.

Biologist-observers to be assigned by LGL will have previous marine mammal observation experience, in many cases aboard seismic vessels, and LGL's field crew leaders will be highly experienced with previous vessel-based seismic monitoring projects. Resumés for those individuals will be provided to NMFS so that NMFS can review and accept their qualifications. Inupiat observers will be experienced in the region, and familiar with the marine mammals of the area. A marine mammal observers' handbook, adapted for the specifics of the proposed SOI seismic program from the handbooks created for previous LGL seismic monitoring projects will be prepared and distributed beforehand to all MMOs (see below).

Most observers, including Inupiat observers, will also complete a two-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2007 open-water season. (Any exceptions will have or receive equivalent experience or training.) The training session(s) will be conducted by LGL marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs.

Primary objectives of the training include:

- review of the marine mammal monitoring plan for this project, including any amendments adopted at the open-water peer review meeting, or specified by NMFS or USFWS in the IHAs, by MMS, or by SOI's Conflict Avoidance Agreement with the AEWC;
- review of marine mammal sighting, identification, and distance estimation methods, including any amendments specified by NMFS or USFWS in the 2007 IHAs;

- review of operation of specialized equipment (reticle binoculars, night vision devices, and GPS system);
- review of, and classroom practice with, LGL's data recording and data entry systems, including procedures for recording data on mammal sightings, seismic and monitoring operations, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer database and laptop computers;
- review of the 2007 Conflict Avoidance Agreement, including the specific tasks of the Inupiat part-time Communicator.

MMO Handbook

A Marine Mammal Observers' Handbook has been prepared for most of the seismic monitoring programs in which LGL has been involved. The handbook contains maps, illustrations, and photographs as well as text and is intended to provide guidance and reference information to trained individuals who will participate as MMOs. The following topics will be covered in the MMO Handbook for the SOI project:

- summary overview descriptions of the project, marine mammals and underwater noise, seismic operations, the marine mammal monitoring program (vessel-based, aerial, acoustic measurements, special studies), the NMFS and USFWS IHAs and other regulations/permits/agencies, the Marine Mammal Protection Act, issues (e.g., subsistence hunt), the Plan of Cooperation, and the Conflict Avoidance Agreement;
- monitoring and mitigation objectives and procedures, safety radii;
- responsibilities of staff and crew regarding the marine mammal monitoring plan and the operations of the seismic vessel;
- instructions for ship crew regarding the marine mammal monitoring plan;
- data recording procedures: codes and coding instructions, common coding mistakes, electronic database; navigational, marine physical, and seismic data recording, field data sheet;
- use of specialized field equipment (reticle binoculars, NVDs, laser rangefinders);
- reticle binocular distance scale;
- table of wind speed, Beaufort wind force, and sea state codes;
- data storage and backup procedures;
- list of species that might be encountered: identification, natural history;
- safety precautions while onboard;
- crew and/or personnel discord; conflict resolution among MMOs and crew;
- drug and alcohol policy and testing;
- scheduling of cruises and watches;
- communications;
- list of field gear that will be provided;
- suggested list of personal items to pack;
- suggested literature, or literature cited.

- Also, copies of the NMFS and USFWS IHAs and the Conflict Avoidance Agreement will be made available.

Monitoring Methodology

The observer(s) will watch for marine mammals from the best available vantage point on the operating source vessel, which is usually the bridge or flying bridge. The observer(s) will scan systematically with the naked eye and 7 × 50 reticle binoculars, supplemented with night-vision equipment when needed (see below). Personnel on the bridge will assist the marine mammal observer(s) in watching for pinnipeds and whales.

The observer(s) will give particular attention to the areas within the "safety radii" around the source vessel. These radii are the maximum distances within which received levels may exceed 180 dB re 1 μPa (rms) for cetaceans, or 190 dB re 1 μPa (rms) for other marine mammals.

Information to be recorded by marine mammal observers will include the same types of information that were recorded during Western Geophysical's 1998-2001 seismic monitoring projects (Moulton and Lawson 2002). When a mammal sighting is made, the following information about the sighting will be recorded:

- Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, apparent reaction to seismic vessel (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace.
- Time, location, heading, speed, and activity of the vessel, and seismic state (e.g., operating airguns, ramp-up, etc.), sea state, ice cover, visibility, and sun glare.
- The positions of other vessel(s) in the vicinity of the source vessel. This information will be recorded by the MMOs at times of whale (but not seal) sightings.

The ship's position, heading, and speed, the seismic state (e.g., number and size of operating airguns), and water temperature, water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables.

Distances to nearby marine mammals, e.g., those within or near the 190 dB (or other) safety zone applicable to pinnipeds, will be estimated with binoculars (Fujinon model FMTRC-SX, 7 × 50) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon.

Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water. However, previous experience showed that this Class 1 eye-safe device was not able to measure distances to seals more than about 70 m (230 ft) away. However, it was very useful in improving the distance estimation abilities of the observers at distances up to about 600 m (1968 ft)—the maximum range at which the device could measure distances to highly reflective objects such as other vessels. In our experience, humans observing objects of more-or-less known size via a standard observation protocol, in this case from a standard height above water, quickly become able to estimate distances within about ±20% when given immediate feedback about actual distances during training.

When a marine mammal is seen within the safety radius applicable to that species, the geophysical crew will be notified immediately so that mitigation measures called for by the IHA can be implemented. As in 1996-2001, it is expected that the airgun arrays will be shut down within several seconds—often before the next shot would be fired, and almost always before more than one additional shot is fired. The marine mammal observer will then maintain a watch to determine when the mammal(s) appear to be outside the safety zone such that airgun operations can resume.

Monitoring At Night and In Poor Visibility

Night-vision equipment ("Generation 3" binocular image intensifiers, or equivalent units) will be available for use when needed. However, our past experience with night-vision devices (NVDs) in the Beaufort Sea and elsewhere shows that NVDs are not nearly as effective as visual observation during daylight hours (e.g., Harris et al. 1997, 1998; Moulton and Lawson 2002).

Specialized Field Equipment

LGL will provide or arrange for the following specialized field equipment for use by the onboard MMOs: reticle binoculars, laser rangefinders, laptop computers, night vision binoculars, and possibly digital still and digital video cameras.

Field Data-Recording, Verification, Handling, and Security

The observers on the seismic source vessel will record their observations onto datasheets or directly into handheld computers. During periods between watches and periods when operations are suspended, those data will be entered into a laptop computer running a custom computer database. The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered, and by subsequent manual checking of the database printouts. These procedures will allow initial summaries of data to be prepared during and shortly after the field season, and will facilitate transfer of the data to statistical, graphical or other programs for further processing. Quality control of the data will be facilitated by (1) the start-of-season training session, (2) subsequent supervision by the onboard field crew leader, and (3) ongoing data checks during the field season.

The data will be backed up regularly onto CDs and/or USB disks, and stored at separate locations on the vessel. If possible, data sheets will be photocopied daily during the field season. Data will be secured further by having data sheets and backup data CDs carried back to the LGL Anchorage office during crew rotations.

In addition to routine MMO duties, Inupiat observers will be encouraged to record comments about their observations into the "comment" field in the database. Copies of these records will be available to the Inupiat observers for reference if they wish to prepare a statement about their observations. If prepared, this statement would be included in the 90-day and final reports documenting the monitoring work.

Field Reports

Throughout the seismic program, the LGL biologists will prepare a report each week (or at such other interval as the IHAs or SOI may require) summarizing the recent results of the monitoring program. The reports will summarize the species and numbers of marine mammals sighted during periods with and without various seismic operations, and the number of shut downs and power downs by species. These reports will be provided to NMFS and to the seismic operators.

Reporting

The results of the 2007 SEPCO vessel-based monitoring, including estimates of "take by harassment", will be presented in the "90 day" and final technical report(s)" Reporting will address the requirements established by NMFS in the IHA.

The technical report(s) will include:

- ❖ summaries of monitoring effort: total hours, total distances, and distribution through study period versus seismic state, sea state, and other factors affecting visibility and detectability of marine mammals;
- ❖ summaries of the occurrence of shutdowns and ramp-up delays;
- ❖ analyses of the effects of various factors influencing detectability of marine mammals: sea state, number of observers, and fog/glare;
- ❖ species composition, occurrence, and distribution of marine mammal sightings including date, water depth, numbers, age/size/gender categories, group sizes, and ice cover;
- ❖ analyses of the effects of seismic operations:
    - sighting rates of marine mammals versus seismic state (and other variables that could affect detectability);
    - initial sighting distances versus seismic state;
    - closest point of approach versus seismic state;
    - observed behaviors and types of movements versus seismic state;
    - numbers of sightings/individuals seen versus seismic state; and
    - distribution around the seismic source vessel versus seismic state;
    - estimates of "take by harassment": based on (a) numbers of marine mammals directly seen within the relevant safety radii, and (b) numbers of marine mammals estimated to be there based on sighting density during daytime hours with acceptable sightability conditions.

COMPREHENSIVE REPORT ON INDUSTRY ACTIVITIES AND MARINE MAMMAL MONITORING EFFORTS IN THE BEAUFORT AND CHUKCHI SEAS

Following the 2007 open water season a comprehensive report describing the proposed acoustic, vessel-based, and aerial monitoring programs will be prepared. The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of industry activities and their impacts on marine mammals in the Beaufort Sea during 2007. The report will form the basis for future monitoring efforts and will establish long term data sets to help evaluate changes in the Beaufort Sea ecosystem. The report will also incorporate studies being conducted in the Chukchi Sea and will attempt to provide a regional synthesis of available data on industry activity in offshore areas of northern Alaska that may influence marine mammal density, distribution and behavior.

This report will consider data from many different sources including two relatively different types of aerial surveys; several types of acoustic systems for data collection (net array, PAM, vertical array, DASARB, and OBH systems), and vessel based observations. Collection of comparable data across the wide array of programs will help with the synthesis of information. However, interpretation of broad patterns in data from a single year is inherently limited. Much of the 2007 data will be used to assess the efficacy of the various data collection methods and to establish protocols that will provide a basis for integration of the data sets over a period of years.

LITERATURE CITED

Brueggeman, J.J., G.A. Green, R.A. Grotefendt, M.A. Smultea, D.P. Volsen, R.A. Rowlett, C.C. Swanson, C.I. Malme, R. Mlawski and J.J. Burns. 1992. 1991 marine mammal monitoring program (seals and whales) Crackerjack and Diamond prospects Chukchi Sea. Rep. from EBASCO Environmental, Bellevue, WA, for Shell Western E & P Inc. and Chevron U.S.A. Inc. Var. pag.

Davis, R.A., W.R. Koski, W.J. Richardson, C.R. Evans and W.G. Alliston. 1982. Distribution, numbers and productivity of the Western Arctic stock of bowhead whales (*Balaena mysticetus*) in the eastern Beaufort Sea and Amundsen Gulf, summer 1981. SC/34/PS20. Int. Whal. Comm., Cambridge, UK. 13 p.

Davis, R.A., C.R. Greene and P.L. McLaren. 1985. Studies of the potential for drilling activities on Seal Island to influence fall migration of bowhead whales through Alaskan nearshore waters. Rep. from LGL Ltd., King City, Ont., for Shell Western E & P Inc., Anchorage, AK. 70 p.

Evans, C.R., S.R. Johnson and W.R. Koski. 1987. Responses of bowhead whales to an offshore drilling operation in the Alaskan Beaufort Sea, autumn 1986: Aerial surveys of whale distribution. Rep. by LGL Ltd., King City, Ontario, for Shell Western E& P Inc., Anchorage. 69 p.

Furgal, C.M., S. Innes and K.M. Kovacs. 1996. Characteristics of ringed seals, Phoca hispida, subnivean structures and breeding habitat and their effects on predation. Can. J. Zool. 74(5):858-874.

Greene, C.R., Jr. 1997. Physical acoustics measurements. p. 3-1 to 3-63 *In:* W.J. Richardson (ed.), Northstar marine mammal monitoring program, 1996: marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. LGL Rep. 2121-2. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc., Anchorage, AK, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 245 p.

Greene, C.R., Jr., and W.J. Richardson. 1988. Characteristics of marine seismic survey sounds in the Beaufort Sea. J. Acoust. Soc. Am. 83:2246-2254.

Greene Jr., C.R. and S.E. Moore. 1995. Man-made noise. P 101-158 In: W.J. Richardson, C.R. Greene Jr., C.I. Malme and D.H. Thomson (editors.), Marine Mammals and Noise. Academic Press, San Diego, California.

Haley, B. and D. Ireland. 2006. Marine mammal monitoring during University of Alaska Fairbank's marine geophysical survey across the Arctic Ocean, August-September 2005. LGL report 4122-3. Report from LGL Alaska Research Associates, Anchorage, AK and LGL Ltd, King City, Ont., for Geophysical Institute, University of Alaska, Fairbanks, AK, and Nat. Mar. Fish. Serv., Silver Spring, MD. 80 p.

Harris, R.E., G.W. Miller, R.E. Elliott and W.J. Richardson. 1997. Seals [1996]. p. 4-1 to 4-42 *In:* W.J. Richardson (ed.), Northstar marine mammal monitoring program, 1996: marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. LGL Rep. 2121-2. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc., Anchorage, AK, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 245 p.

Harris, R.E., A.N. Balla-Holden, S.A. MacLean and W.J. Richardson. 1998. Seals [1997]. p. 4-1 to 4-*54 In:* W.J. Richardson (ed.), Marine mammal and acoustical monitoring of BP Exploration (Alaska's) open-water seismic program in the Alaskan Beaufort Sea, 1997. LGL Rep. TA2150-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc., Anchorage, AK, and U.S. Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 318 p.

Harris, R.E., G.W. Miller and W.J. Richardson. 2001. Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. **Mar. Mammal Sci.** 17(4): 795-812.

HESS. 1999. High Energy Seismic Survey review process and interim operational guidelines for marine surveys offshore Southern California. Report from High Energy Seismic Survey Team for California State Lands Commission and U.S. Minerals Management Service [Camarillo, CA]. 39 p. + App. Available at www.mms.gov/omm/pacific/lease/fullhessrept.pdf

Holst, M., M.A. Smultea,. W.R. Koski, and B. Haley. 2005. Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory's marine seismic program off the Northern Yucatán Peninsula in the Gulf of Mexico, January–Feburary 2004. LGL Rep. TA2822 31. Rep. from LGL Ltd., King City, Ont., for Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY, and Nat. Mar. Fish. Serv., Silver Spring, MD. 96 p.

Ireland, D., M. Holst, and W.R. Koski. 2005. Marine mammal monitoring during Lamont-Doherty Earth Observatory's seismic program off the Aleutian Islands, Alaska, July–August 2005. LGL Rep. TA2822-32. Rep. from LGL Ltd., King City, Ont., for Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY, and Nat. Mar. Fish. Serv., Silver Spring, MD. 67 p.

Johnson, S.R., C.R. Greene, R.A. Davis and W.J. Richardson. 1986. Bowhead whales and underwater noise near the Sandpiper Island drillsite, Alaskan Beaufort Sea, autumn 1985. Rep. from LGL Ltd., King City, Ont., for Shell Western E & P Inc., Anchorage, AK. 130 p.

Kelly, B.P. and L.T. Quakenbush. 1990. Spatiotemporal use of lairs by ringed seals (Phoca hispida). Can. J. Zool. 68(12):2503-2512.

Koski, W. R. and S. R. Johnson. 1987. Behavioral studies and aerial photogrammetry. Section 4. *In* Responses of bowhead whales to an offshore drilling operation in the Alaskan Beaufort Sea, autumn 1986. Report from LGL Ltd., King City, Ontario, and Greeneridge Sciences Inc., Santa Barbara, CA, for Shell Western Exploration and Production Inc., Anchorage, AK.

Lawson, J.W., W.R. Koski, D.H. Thomson and W.J. Richardson. 1998. Chapter 4.7 Marine Mammals: Environmental Consequences. *In*: Environmental Impact Statement/Overseas Environmental Impact Statement Point Mugu Sea Range. Prepared by LGL Limited, King City, Ontario, and Ogden Environmental and Energy Services, Santa Barbara, CA, for Dep. Navy, Naval Air Warfare Center Weapons Division, Point Mugu, Ca and Southwest Division Naval Facilities Engineering Command, San Diego, CA.

Lydersen, C. and M. Ryg. 1991. Evaluating breeding habitat and populations of ringed seals Phoca hispida in Svalbard fjords. Polar Record 27(162):223-228.

Manly, B.F.J., V.D. Moulton, R.E. Elliott, G.W. Miller and W.J. Richardson. 2004. Analysis of covariance of fall migrations of bowhead whales in relation to human activities and environmental factors, Alaskan Beaufort Sea: Phase I, 1996-1998. Report by LGL Limited, King City, ON, and WEST Inc, Cheyenne,WY, for Minerals Management Service, Herndon, VA and Anchorage, AK. 128 p.

Miles, P.R., C.I. Malme, and W.J. Richardson. 1987. Prediction of drilling site-specific interaction of industrial acoustic stimuli and endangered whales in the Alaskan Beaufort Sea. OCS Study MMS87-0084.

Miller, G.W., R.E. Elliott, W.R. Koski and W.J. Richardson. 1997. Whales. p. 5-1 to 5-115 *In*: W.J. Richardson (ed.), Northstar marine mammal monitoring program, 1996: marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. LGL Rep. 2121-2. Rep. from LGL Ltd., King City, ON and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc. and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 245 p.

Miller, G.W., R.E. Elliott and W.J. Richardson. 1998. Whales. p 5-1 to 5-123 *In*: W.J. Richardson (ed.), Northstar marine mammal monitoring program, 1997: marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. LGL Rep. 2150-3. Rep. from LGL Ltd., King City, ON and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc. and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 318 p.

Miller, G.W., R.E. Elliott, W.R. Koski, V.D. Moulton, and W.J. Richardson. 1999. Whales. p. 5-1 to 5-109 *In*: W.J. Richardson (ed.), Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Rep. TA2230-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and U.S. Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 390 p.

Miller, G.W., V.D. Moulton, R.A. Davis, M. Holst, P. Millman, A. MacGillivray and D. Hannay. 2005. Monitoring seismic effects on marine mammals-southeastern Beaufort Sea, 2001-2002. pp 511-542 *In*: S.L. Armsworthy, P.J. Cranford, and K. Lee (eds.), Offshore oil and gas environmental effects monitoring/Approaches and technologies. Battelle Press, Columbus, OH.

Moore, S.E., and DeMaster, D.P. 1998. Cetacean habitats in the Alaskan Arctic. **J. NW Atlantic Fish. Sci.** 22:55-69.

Moore, S.E., DeMaster, D.P., and Dayton, P. K. 2000. Cetacean habitat selection in the Alaskan Arctic during summer and autumn. **Arctic** 53(4):432-447.

Moulton, V.D. and J.W. Lawson. 2002. Seals, 2001. p. 3-1 to 3-48 *In*: W.J. Richardson (ed.), Marine mammal and acoustical monitoring of WesternGeco's open water seismic program in the Alaskan Beaufort Sea, 2001. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for WesternGeco, Houston, TX, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. LGL Rep. TA2564-4.

Moulton, V.D., W.J. Richardson, R.E. Elliott, T.L. McDonald, C. Nations and M.T. Williams. 2005. Effects of an offshore oil development on local abundance and distribution of ringed seals (*Phoca hispida*) of the Alaskan Beaufort Sea. **Mar. Mamm. Sc**i. 21(2):217-242.

NMFS. 1995. Small takes of marine mammals incidental to specified activities; offshore seismic activities in southern California. **Fed. Regist.** 60(200, 17 Oct.):53753-53760.

NMFS. 2000. Small takes of marine mammals incidental to specified activities; marine seismic-reflection data collection in southern California/Notice of receipt of application. **Fed. Regist.** 65(60, 28 Mar.):16374-16379.

Rugh, D.J. and M.A. Fraker. 1981. Gray whale (*Eschrichtius robustus*) sightings in eastern Beaufort Sea. **Arctic** 34(2):186-187.

Thomas, T.A., Koski, W.R. and Richardson, W.J. 2002. Correction factors to calculate bowhead whale numbers form aerial surveys of the Beaufort Sea. Chapter 15. *In*: W.J. Richardson and D.H. Thomson (eds.). Bowhead whale feeding in the eastern Alaskan Beaufort Sea: Update of Scientific and Traditional Information. 28pp. OCS Study MMS 2002-012.

Treacy, S.D. 1998. Aerial surveys of endangered whales in the Beaufort Sea, fall 1997. OCS Study MMS 98-059. U.S. Minerals Manage. Serv., Anchorage, AK. 143 p.

Treacy, S.D. 2000. Aerial surveys of endangered whales in the Beaufort Sea, fall 1998-1999. OCS Study MMS 2000-066. U.S. Minerals Manage. Serv., Anchorage, AK. 135 p.

Treacy, S.D. 2002. Aerial surveys of endangered whales in the Beaufort Sea, fall 2000. OCS Study MMS 2002-014. U.S. Minerals Manage. Serv., Anchorage, AK. 111 p.

Williams, M.T., T.G. Smith, and C.J. Perham. 2002. Ringed seal structures in sea-ice near Northstar, winter and spring of 2000-2001. Pages 4-1 through 4-32 in W.J. Richardson and M.T. Williams (eds.) 2002. Monitoring of industrial sounds, seals, and whale calls during construction of BP's Northstar Oil Development, Alaskan Beaufort Sea, 2001. Report by LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Exploration (Alaska) Inc., Anchorage AK, and Nat. Mar. Fish Serv., Anchorage, AK and Silver Springs, MD.